AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

SEPTEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

III.

(*Continued from page* 169.)

The focus of Altoona is the Logan House, a hotel which was built soon after the shops were located there, and which is now in the center of the city on the north side of the railroad tracks, the great locomotive repair shops being on the south side and opposite to the hotel. The hotel is not shown in the plan of the shops, which was published in our June number.

For convenience of reference this plan is reprinted herewith, and the position of the hotel is indicated in the reprint. The erecting shop, No. 1, shown in the plan, is directly opposite to the hotel and first attracts attention. It was, we believe, the first shop of the kind in this country which was built with longitudinal tracks and overhead traveling cranes, and has been the subject of frequent study and much criticism by railroad men ever since it has been erected. The cranes were made in England and are carried in brick arches along the sides of the shop. These are large and cumbrous and exclude a good deal of light, and would not be repeated if the shops had to be rebuilt. In fact it is said that the cranes which were originally put into this shop are now too light for the heavy engines which must be handled, and plans are under consideration to replace the cranes with heavier ones, and substitute an iron supporting structure to carry them.

Erecting shop No. 2 forms a part of the same group of buildings and is similar to No. 1, and has three longitudinal tracks with a pair of overhead travelling cranes which were built in Altoona. They, too, are carried on brick arches, but these are arranged so as to light the shop better than No. 1 is lighted. The two side tracks each have a pit, while the centre one has not. The engines to be repaired are placed on the side tracks, and the middle one, as far as possible is kept clear. The space between the middle and side tracks is excavated and covered over. In these basements, as they may be called, the water and steam pipes for heating the building and testing boilers are located, In the No. 1 shop the pump and accumulator for the water pressure, are located under the floor. The boilers are all tested first by a cold water hydraulic test, and then with hot water and steam pressure. For both tests the water is conducted to the boilers by the system of pipes described, and in making the steam test the boilers are entirely filled with water, which is then heated, and expanded with steam from the steam pipes.

The space below the floor is also used for storing the parts of engines, which are brought in for repairs, and are dismantled. The woolen floor is removable which enables the parts to be easily deposited in the basements and taken out again when they are needed.

There is room for nine engines on each track and about 34 can be repaired and turned out each month in each shop, although the average is not as great as that number. The cranes are not very rapid in their movements and for that reason they are used for handling only the heaviest parts of the locomotives which are being repaired. As has often been explained, any engine can be lifted up bodily and transferred laterally over the middle track, and then moved longitudinally to any point in the shop, and again carried over to either side track and placed wherever it may be required. In this way, if for any reason it is desirable to give precedence to some engine, it can be taken up and placed in any desired position.

These shops and the appliances in them have now been in use for a good many years and although the relative merits of shops with longitudinal and transverse tracks is still a much-disputed question it would be hard to find any one about Altoona who would advocate the building of an erecting shop with transverse tracks and a transfer table, which is the usual plan adopted in this country.

The general arrangement of these shops may be commented on. The machine shop is a two-story building centrally located between the two erecting shops, with which it is connected by wings at the south end. At the north each of the three parallel shops abuts against a transverse building with tracks leading out to a transfer table. In this shop the cylinders, frames, trucks, etc., are assembled, and put together, preliminary to being taken into the erecting shops. Between the machine and erecting shops there are open spaces where wheels, castings, etc., are stored temporarily before being taken into the shop. West of the transfer-table is the wheel shop, smithy and boiler shops. The wheel shop is in a direct line with the machine shop, and all the buildings last referred to are connected with the transfer table and by that means material or partly finished work can be carried to any part of the machine or erecting shops. Still farther north is the wheel foundry and another larger foundry for general castings. The brass foundry and other smaller buildings are distributed as shown in the plan from which it will be seen that what may be called the co-relation of the shops is very convenient and that although the present arrangement of buildings has been the result of a process of evolution it has not been without a system which has evidently been carefully thought out. The location of the three round houses Nos. 1, 2 and 3 is shown and also that of the testing laboratory which is now famous the world over.

At the time of our visit to the erecting shops all the engines in No. 1 it was noticed had Belpair boilers. The Pennsylvania Railroad has adopted this form of boiler more extensively than any other line in this country, and, apparently, have no present intention of abandoning it, but are applying it to all new engines which are built and to old ones which are rebuilt. It is true that some of the earlier boilers of this type, which were too small, have been removed and are now used in stationary service, but the number is constantly being increased and the type is adhered to, which indicates that it has been giving satisfaction. Some

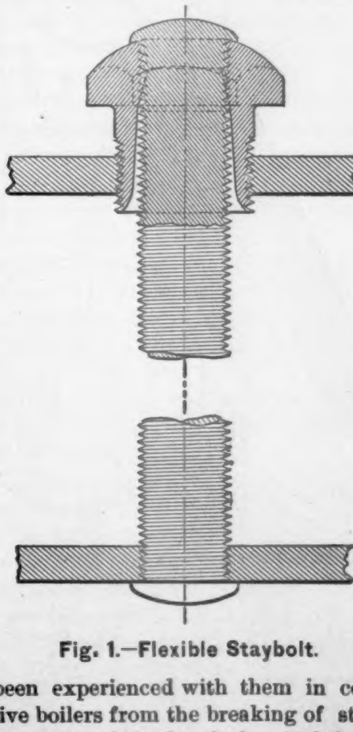
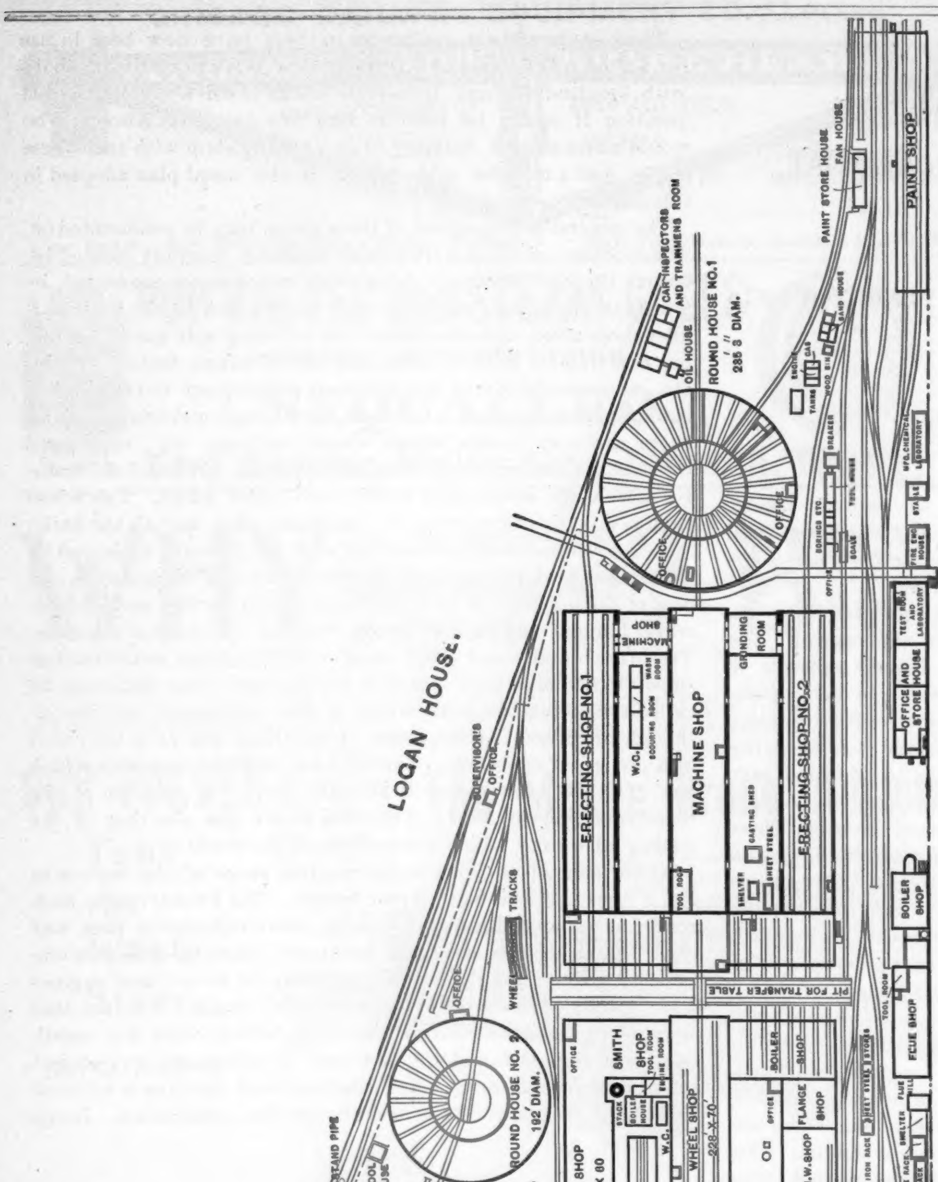


Fig. 1.—Flexible Staybolt.

trouble has been experienced with them in common with all other locomotive boilers from the breaking of stay-bolts. It was observed that more stay-bolts break in steel than in iron plates, and that the tighter the bolts are screwed into the plates the larger the number of breakages were. From this and other facts the inference was drawn that the rigidity of the bolts had much



PLAN OF LOCOMOTIVE REPAIR SHOPS, ALTOONA, PA.

to do with their failure. Mr. Joseph Nixon, the foreman of the boiler shops, was therefore led to design the form of attachment shown in Fig. 1, which permits of some degree of flexibility in the bolt, and also provides a more secure fastening. It consists of a nut with a tapered thread $1\frac{3}{8}$ inches in diameter which is screwed into the outside plate of the fire box. The hole on the inside of the nut is tapered, and "runs off to nothing" in the thread, which is cut in the outer end of the hole. The point of flexure of the bolt is thus distributed over some distance and is not concentrated at one point. The bolt is riveted over the outside of the nut, as is usual, and the inside end is screwed and riveted into the fire-box plate in the usual way. The nuts were first made of brass, but are now made of malleable iron. They were first applied to boilers in 1892, and they worked so satisfactorily that they have gradually been used more and more, and now orders have been given to apply them to all boilers which go through the shops. Thus far no bolts have been found broken which are fastened in this way. They are put in the upper rows which are most liable to break, and in some engines in all places where the nuts will not interfere with the attachments to the boilers. The drilling of the ends of stay bolts it has been found will not always reveal a fracture if it occurs, and it was partly for that reason and also to lessen the cost of repairs that this method of fastening bolts was designed by Mr. Nixon and adopted by the company.

A good many years ago the Pennsylvania Railroad had in its equipment a number of Winans Camel engines which some of our older readers will remember had fireboxes, the crown sheets and tops of which sloped downward and backward from the barrel of the boiler, and were stayed with ordinary stay-bolts. Later the Pennsylvania Railroad Company built some consolidation engines with similar fireboxes which have been known as Class I engines. It is said of the boilers of these engines that they are the cheapest to maintain of any on the road, as they are also the lightest boiler in proportion to their size of any in use. Having some interest in this we made inquiry and ascertained the weights of three classes of boilers: 1st, Class I, of the kind

described; 2d, Class A, for anthracite coal, but having a wagon top and crown-bars, and Class R, a Belpaire boiler. The following table gives the weights of the boilers as they leave the boiler shops without flues, their heating surface and the weight per square foot of heating surface:

Class.	Weight of boiler.	Heating surface.	Weight per square foot of heating surface.
	Pounds.	Feet.	Pounds.
I	11,413	1,259.5	9.06
A	16,361	1,205.0	13.57
R	18,850	1,731.0	10.89

The weight of the Class I boiler included water grates, whereas the others did not. It will be seen that it weighs 1.83 pounds per square foot of heating surface less than a Belpaire boiler, and 4.51 pounds less than one with crown-bars. In a boiler with 2,000 square feet of heating surface there would, therefore, be a difference of more than 3,660 pounds in the weight of a Belpaire boiler, and one of the Class I type and over 9,000 pounds between a boiler of the latter type and one with a crown sheet supported by crownbars. The comparison is, perhaps, not quite fair, for the reason that the Belpaire boiler was designed to carry a higher pressure than the others were intended for, but, after allowing for this, the fact remains that boilers of the camel type are lighter than any other form in use, and are easier to maintain, not slight advantages. As the objection is sometimes made to them that they do not carry water well, we made special inquiries with reference to that point. The testimony relating to this point was a little conflicting regarding the class I boiler which was probably deficient in steam room. Men who ran camel engines, and still survive, say that they always carried water very well. They had, however, high domes which were very large in diameter, and located at the front of the boiler near the front tube-sheet. If the only difficulty with boilers of this kind is that of carrying water satisfactorily it would, therefore, seem that it is remediable. The figures indicate that the capacity of a boiler of this kind, of a given weight would be about 20 per cent, greater than one of the Belpaire type, and the difference would be still greater if the comparison was made with one having crownbars. These are certainly no small advantages.

It is a curious fact that in piecing out flues in different shops in the country there are a greater variety of methods in use than are employed in doing any other kind of work. At Altoona there is one of the best equipped and most convenient flue shops that we know of. It is a large, well lighted and ventilated building apart from the boiler shop and just south of it. The flues when they are brought in to be pieced are first put into a "rattler," and the scale is cleaned off. The rattlers used here are cylinders of about 30 inches diameter, which are formed by bolting long cast-iron bars of T section to circular discs or heads attached to a suitable shaft. One of these bars is removable, and the flues are put inside of the cylinder through the opening which is left when it is removed. Between the others there are open spaces or slots about ⅜ inch wide. Formerly flues were rattled dry, but now the practice is to put them into the rattler with broken furnace slag and then conduct a stream of water, by a perforated pipe, which extends the whole length of the rattler—the water entering through the open spaces left between the bars. It is said that a given number of flues can be cleaned by the wet process in less than half the time than is possible if they are "rattled" dry.

After being cleaned the next step is to cut them off to the proper length, and scarf the ends of the flues externally, the piece to be welded on being scarfed internally. They are then driven together, heated in a coke fire and welded in a very simple machine, consisting in a revolving horizontal shaft which enters the inside of the flue. Another parallel shaft carries a roller, about 3 in. diameter and 2½ in. face, which can be raised and lowered in relation to what may be called the bearing shaft, and after the heated flue, which is to be welded; is placed in the latter, the roller is pressed down on the heated joint and the welding is effected in a few seconds. The two shafts are geared and revolve together. The machines are made by J. Sadler, of New York.

After being pieced in this way, the flues are tested in a hydraulic tester. This is arranged so as to fill the tube with water taken from the water supply. At the same time the water flows into what was originally a pump cylinder of a Westinghouse brake pump, containing a piston. The water enters the cylinder below the piston and raises it up. When the flue and the cylinder are filled the water connection is closed, and compressed air is admitted above the piston in the cylinder. This is proportioned so as to give the requisite pressure in the flue, and the test is thus made almost instantly. After being tested the flues are swaged down at one end, which is ground to receive a copper ferrule. This is brazed to the tube, and is in turn also ground on its outside surface. It has been found that when tubes leak, that the leak is more likely to occur between the tube and the ferrule, and not between the ferrule and tube plate, and that the brazing prevents such leakage.

Another method of putting in flues has recently been tested. This consists in putting the ferrule into the hole in the tube sheet and rolling it before the tube is put in. Afterwards the tube is put in and rolled inside of the ferrule.

This shop has a capacity for handling about 11,000 flues per month, the average output being about 8,000. All the work is done by piecework, as is the case in most of the shops in Altoona, which system is popular with the men and is profitable to the company. The general verdict is that there is no practical difficulty in securing good work by careful inspection, and that it is no more trouble to inspect work under the piece system than it is to inspect the men when they work by the day and keep them up to their duties.

The system of piece work has been very generally adopted in all the shops, even in round house repairs, and in such work as washing windows with the result of a great reduction in cost. The system is generally liked by officers and men and it would be difficult to induce the authorties at Altoona to return to the days work system after the experience they have had. It is said that the piece work system saves 65 per cent. on the cost of labor. There were of course at first many difficulties in introducing this method, one of the chief of which was, the making of a scale of prices, which took three years to perfect, and which now requires amendment at times. Besides the advantages named work is done quicker and can be hurried more than is possible when men are working by the day. In this way more work can be done with a given equipment than is possible with the old method. The inspection is done by the foreman or a special person appointed for that duty. It is upon the inspection that the success of the system of piece work is dependent. It is said that but little trouble is experienced from bad work.

One of the most interesting places in Altoona is the testing department and laboratory, which has acquired a world wide reputation. It occupies a three-story building 40 by 72 feet, located on the south side of the ground owned by the company. The chemical laboratory, under the charge of Dr. C. B. Dudley, occupies the whole of the third story and about half of the second, The first floor is devoted to the department of physical tests, under the charge of Mr. A. W. Gibbs.

The chemical laboratory is very fully equipped with every requisite for analyzing the great variety of materials which are bought and used in the operation of a great road like the Pennsylvania. The purchase of material by this company amount to many millions annually, and cover a great variety of substances, These include metals of different kinds, such as iron, steel, copper, brass, lead, zinc, etc., paints, oils, soaps, petroleum products of various kinds, caustic soda, blue vitrol, sal ammoniac, disinfectants, mineral wool, magnesia, boiler coverings, India rubber, etc., etc. The aim of those who conduct the laboratory is first to establish a standard of qualities which the material that is bought should possess, and then make specifications of these qualities by which they are bought, and to which they must conform. This alone has required an immense amount of investigation,

study and research. At present about thirty-five specifications of this kind have been formulated, and all the materials to which these refer are bought to conform thereto. When the material is delivered samples are sent to the testing department, properly labeled, and designated by the number of the requisition under which it was ordered, and none of the material can be used, excepting in emergencies, until the samples have been inspected and analyzed to ascertain whether they comply with the specifications. As soon as the analyses are made reports thereon are sent to the superintendent of the motive power department, and the holders of the materials are duly notified whether it does or does not comply with the requirements. If it does it is accepted and used, if not the parties who supplied it are notified and it is returned to them. Some of the materials are subjected to both chemical analysis, and to physical tests before being accepted. The ascertainment of the qualities and characteristics, which all these different materials should have of course, implies as has been said an immense amount of special knowledge, and these which have been prepared were evolved as the result of the work of this unique department of the Pennsylvania railroad during the many years of its existence and are the results of much labor, research and experience. The great variety of materials which are bought by and are sold to railroad companies are, of course, subject to all kinds of deterioration, adulteration and falsification. Sometimes this arises from the ignorance of dealers or manufacturers; in others it is more culpable. It is the business of the testing department to ascertain whether the materials bought have the qualities required. There are, of course, some things which require only to be inspected, and not tested, and for that reason inspectors are employed, but these belong chiefly to the physical test department, and are sent wherever their services are required. That a private individual firm or a great company will be liable to be cheated if it does not know what kind of materials are supplied to it, or if its knowledge of what it gets is supplied only in a very casual, desultory and unsystematic way, would hardly appear to require any proof. The Pennsylvania Railroad Company has organized its test department in a thoroughly systematic manner to do what every prudent business man does when he buys anything. The magnitude of the transactions of the railroad company of course requires that the organization and scope of this department should correspond thereto in order to accomplish its purpose. In another article a fuller detailed description will be given of the work which has been and constantly is being done, with some reports of the results which have been accomplished thereby.

(To be Continued.)

Communications.

Sensational Tests of Car Weeels.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

The interesting account on page 92 of your June issue of certain "thermal tests" of car wheels, made at Altoona, is calculated to excite alarm and to weaken confidence in cast-iron car wheels.

A little reflection will, I think, convince those who are familiar with the manufacture and use of car wheels that this test is entirely unlike any conceivable conditions, even of severest service. Prolonged action of brakes cannot approximate such a condition, although car wheels are frequently observed to be *very much hotter*, when examined at the bottom of a long descending grade, than your account shows sufficed to crack the test wheels, without any evidence of cracking in plate or brackets.

Pouring an annular lake of molten iron around the rim of a car wheel does not, at all, imitate the condition which obtains when brakes are suddenly and continuously applied, therefore no proper deductions can be drawn therefrom; though the *prima facie* reason why one wheel cracked under such a test and another did not, would appear to be that the cracked wheel had a deeper chilled tread and would, therefore, have proved a more serviceable wheel for the purpose for which it was designed, viz., to show good mileage in actual service.

Some years ago the wheels made at Altoona were cast by what was then called the "sand-flange process," and wheels cast in this way would, presumably, resist this extraordinary "thermal test" better than similar wheels cast in a chill not provided with the sand flange.

In 1881, when I last visited the Altoona shops, the sand-flange power process had been in daily use for more than five years and it would no doubt be equally applicable to contracting chills which are now generally used.

This process is simply providing a groove about ⅝ inches wide, ⅝ inches deep in the flange portion of a chill; this groove is filled with sand, properly packed to preserved the shape of the flange and an annular chamber about ⅛ inch wide and ⅛ inch deep with a few vent holes to carry off the steam generated in the sand rammed in the groove, while casting the wheel.

The practical effect of this arrangement was to decrease the chill of the flange of the wheel, without affecting the depth of chill on the tread. This difference would probably be sufficient to prevent the occurrence of a crack through the flange, which would, of course, immediately cause a crack in the brackets, followed by a crack through the plate.

I do not know whether the Altoona wheel was cast in this manner, or whether it was deficient in chill, but I regard the test as a sensational and misleading one, representing impossible conditions and likely to cause unnecessary alarm unless properly understood.

Not having been connected with car-wheel manufacture since 1887, I feel free to criticize this test. C.

[Our correspondent's observation that "the *prima facie* reason why one wheel cracked under such a test, and another did not, would appear to be that the cracked wheel had a deeper chilled tread," it is to be feared is a mere hypothesis, and may or may not be true, but is valueless as a basis for drawing any reliable deduction. Whether the wheels which were broken were or were not cast with a sand flange we are not able to say, neither do we know whether that method of casting "would probably be sufficient to prevent the occurrence of a crack through the flange." In cases like this it is well to keep in mind the maxim "that things which are not quite sure are very uncertain." Nor is it quite clear why the test referred to should be regarded as "sensational." That car wheels break when their rims are suddenly heated to comparatively low temperatures is surely a fact of importance in view of the experience, which is not uncommon, of more or less mysterious breakages of wheels in service, attended at times with loss of life or limb, and always by loss of property. It would or should be more sensational if such a fact did not receive very serious consideration by those who are interested with the responsibility of carrying us safely when we travel on railroads.—EDITOR.]

Indicator Rigging for Locomotives.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

There is a mistake in the latter part of the article in your June issue on the Indicator Rigging used on the Pennsylvania Railroad, where it is stated that the rigging illustrated is the development of one used by Professor Goss, whereas it is the development of one first used and illustrated by Mr. Dean or George Strong.

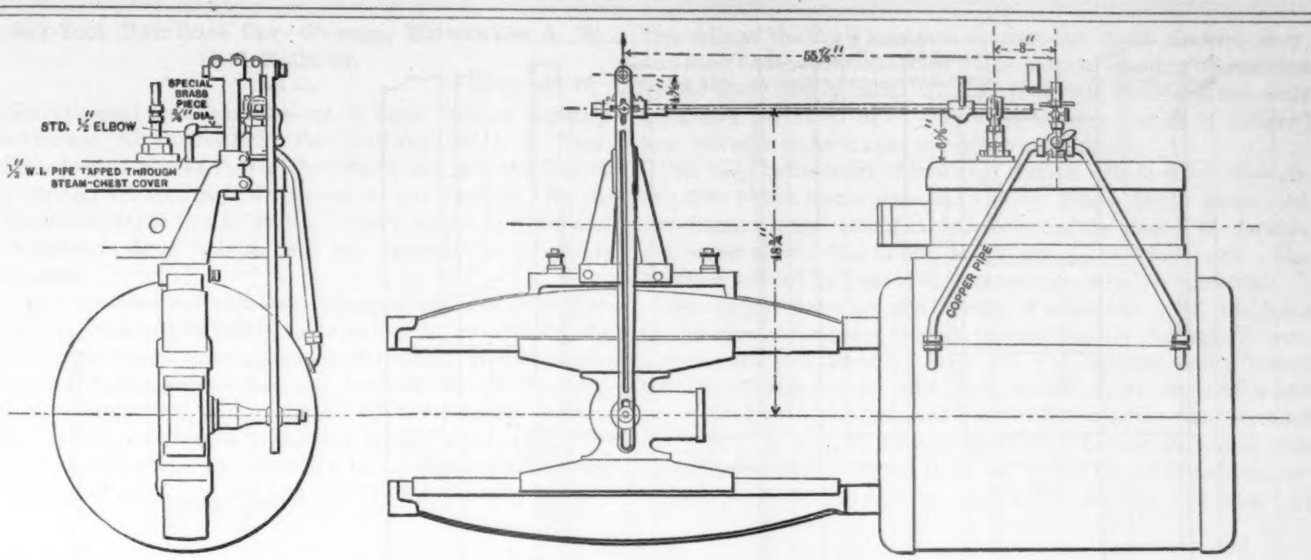
I send you with this letter prints showing the general arrangement and details of our latest rigging, which is a modification of that used by Professor Goss. It was made for use on our new mogul compounds, as the pantograph rigging was not adapted to the increased stroke and higher steam chests of the compounds. The pantograph rigging is an accurate one and has been used at speeds over 80 miles per hour, but service has shown it to possess two disadvantages:

First. The workmanship has to be very excellent to prevent lost motion.

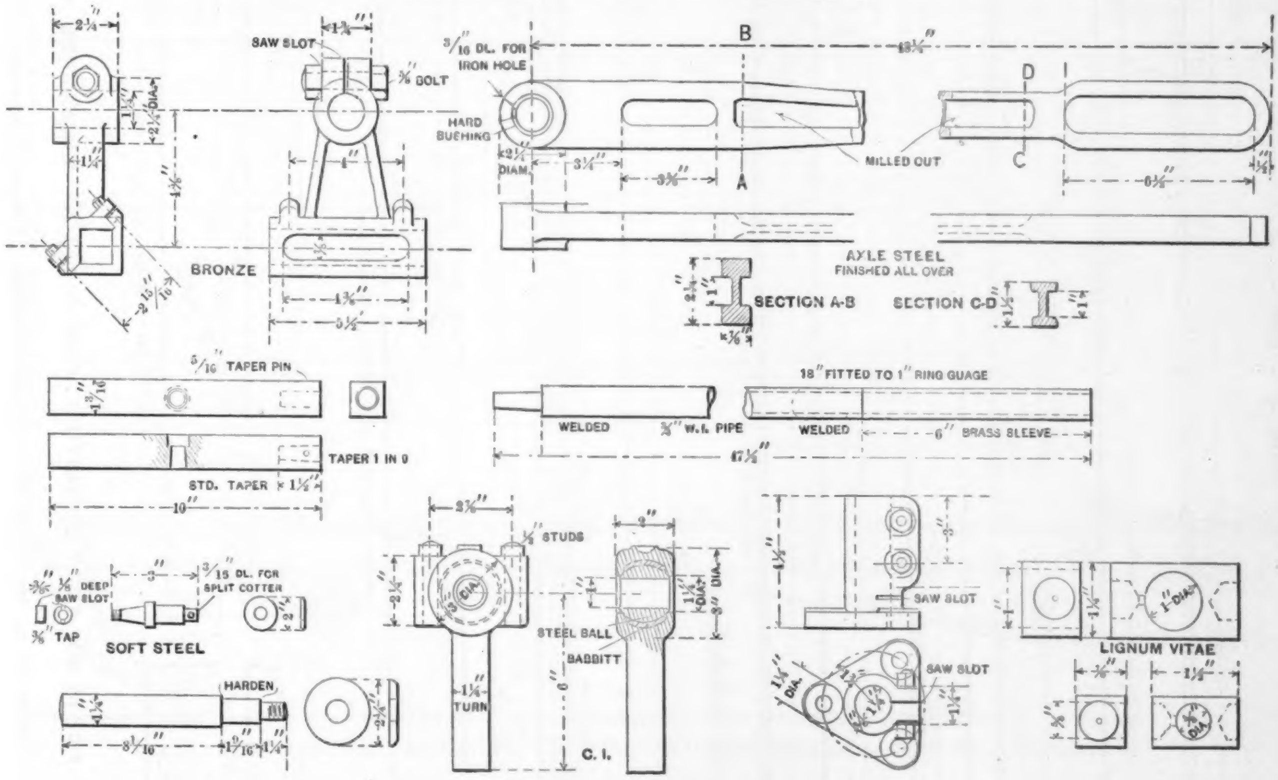
Second. It is too flexible laterally, and the side tremors set up are communicated to the motion rod, and thence to the indicator drum.

The motion shown in the blue prints sent you is an equally accurate and much simpler one, and, as will be noticed, uses several parts of the pantograph motion.

Trial shows that it wears better and is not subject to the same vibration as the other motion, but has not the same range of vertical adjustment. It has provision for taking up the wear where necessary, and the steam-chest bearing for the motion rod is much



General Arrangement of Indicator Rigging.



Details of Indicator Rigging.

better than that illustrated by you in June. Brass sliding blocks in the slots of the lever were found to wear too fast, and have been supplanted with others of lignum vitæ, which wear very much better. The details are so plain as to need no explanation.

For engines with a short stroke and high steam chests, the fulcrum of the lever could well be placed between the slots, and would allow a much shorter and stiffer stand, but the angle of the slots to the line of motion would be less favorable, and there might be some trouble from sticking.

In conclusion, I think that where it is necessary to adapt one rigging to a number of engines of different types, the pantograph motion is to be preferred, but where one can afford to make special levers of different lengths, the one shown is most satisfactory.

Yours truly,

A. W. Gibbs,
Assistant Mechanical Engineer, Pennsylvania Railroad,
Altoona, Pa.

[The prints reproduced herewith need but little explanation. The lever is shown in detail, also the lignum vitæ sliding blocks. The lever fulcrum and means for adjusting it are much the same as in the illustrations in our June issue. The fulcrum pin is clamped firmly in the fulcrum and between the latter and the lever is a motion-rod guide clamped to the same pin. It provides a support for the square end of the motion-rod, and the square end, which is 10 inches long, is drilled for a pin which also passes through the sliding block in the lever. The support for the motion rod at the steam-chest end consists of an adjustable standard with a steel ball in a babbitted socket, the rod passing through a hole in the ball. The method of attaching the cord is the same as in the other rigging.

This rigging and the one previouslyl illustrated are two excellent examples of serviceable rigs, the one illustrated in June being adjustable to a number of locomotives of different dimensions, while the one here shown is simpler and has fewer parts, but is not adjustable to the same extent as the former one. It would probably require a new lever for each class of engine, all the other parts being retained. But as Mr. Gibbs has pointed out, it is a better rig than the pantograph, and while the cost of several levers may be raised as an objection, it should be remembered that the cost of keeping lost motion out of the pantograph will in a measure offset this expense where much indicating is done. —Editor.]

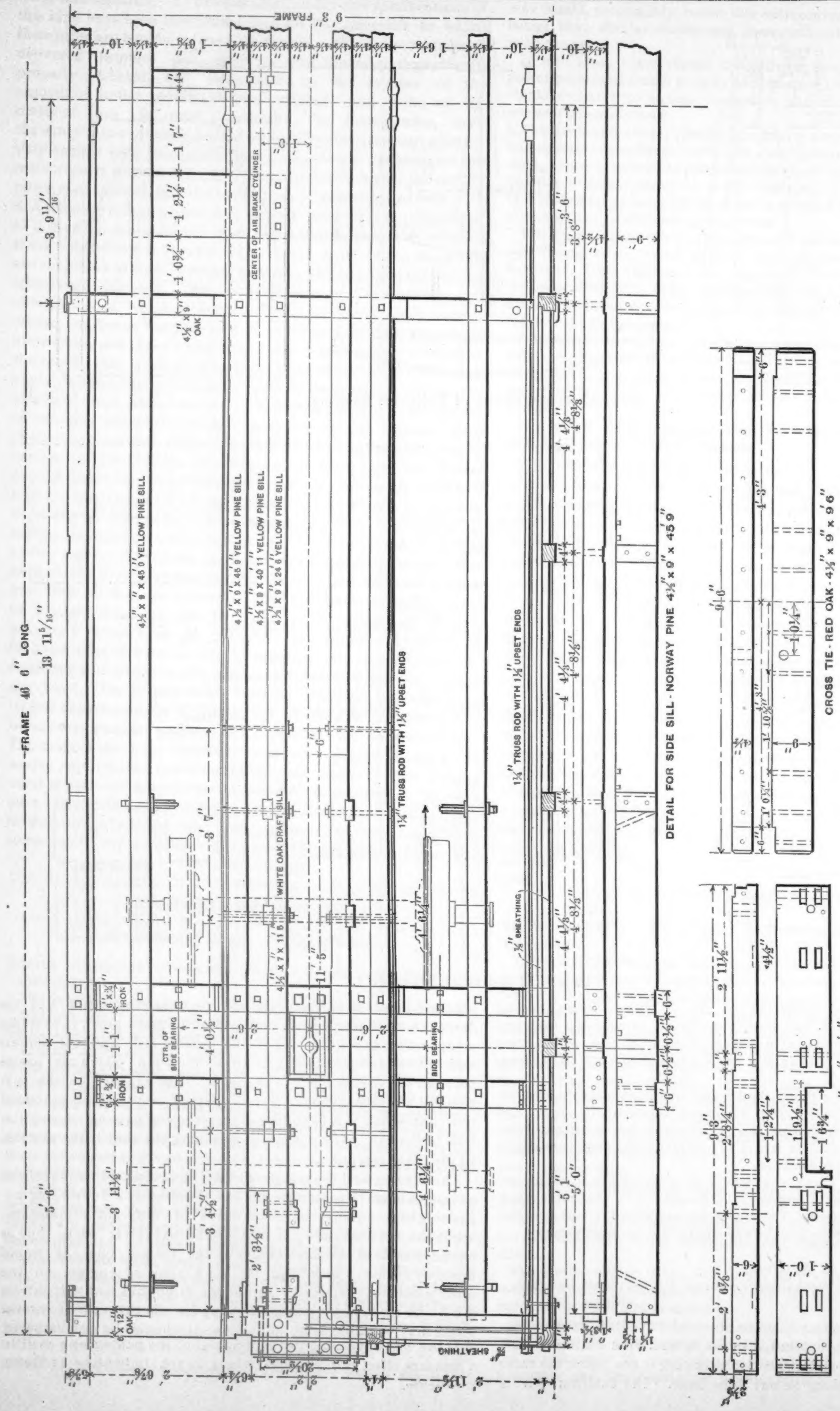


FIG. 1.—UNDERFRAME OF FORTY-SIX FOOT FURNITURE CAR—CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

Designed by Mr. J. N. Barr, Superintendent of Motive Power.

Forty-Six-Foot Furniture Car—Chicago, Milwaukee & St. Paul Railway.

To meet the need for a furniture car of large cubical capacity on the Chicago, Milwaukee & St. Paul Railway, Mr. J. N. Barr, Superintendent of Motive Power, designed a car, the drawings of which, through his courtesy, we present to our readers. Its inside dimensions are 46 feet in length, 8 feet 9 inches in width and 9 feet 3 inches in least height, and the capacity in weight is 60,000 pounds.

The car is remarkable for its size, though there have been constructed furniture cars 50 feet or more in length; but usually the cars of extreme length have a capacity of less than 60,000 pounds. The most interesting part of this car, however, is the framing, which, upon inspection, will be found to differ from common practice. In the underframes the arrangement of sills is novel. Ordinarily the longitudinal members of a frame for a car of this size would consist of eight sills and two draft timbers backed by sub-

The bolts of the draft lugs pass through the draft timbers only, and their nuts are accessible in the pocket or opening occasioned by the short center sills. The construction described not only facilitates the removal of the draft timbers, but it is believed that will also make it easy to replace a center sill.

The body bolsters are of iron and double. Each truss consists of a 6 by ¾-inch upper plate and a 6 by 1-inch lower plate. At the center a large casting extends between the trusses to receive the center plate. The needle beams are 4½ by 9-inch oak. The frame is trussed by four 1¼-inch truss rods, with 1½-inch ends.

The upperframes are also worthy of attention. All the posts on the sides and ends of the car project slightly through the outside sheathing of the car. They are not tenoned and mortised into the top faces of the sills, but extend down their sides and are secured by horizontal bolts, in addition to the usual vertical tie rods. It will be noticed that the sills are gained ½ inch deep for the posts. These posts are 3 by 4 inches in section, except at the doors and corners, where they are 4 by 4 inches. At

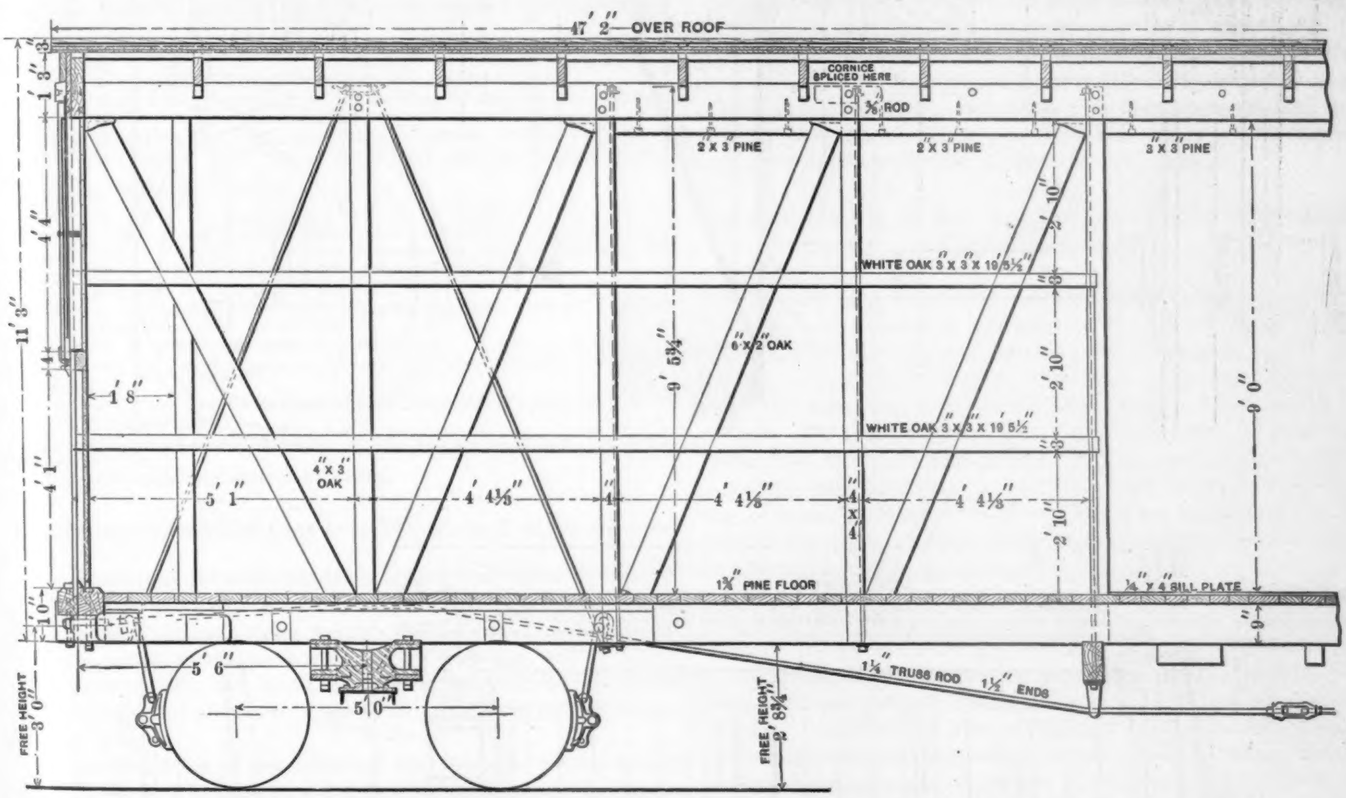


Fig. 2.—Framing of Forty-six Foot Furniture Car.—Chicago, Milwaukee & St. Paul Railway.

sills under the center sills to make them practically continuous. In this car there are the same number of longitudinal members, but, as is clear from Fig. 1, they are all in the same horizontal plane. The draft timbers are placed against the inside faces of the center sills, and against the outside faces of the latter are placed the first intermediate sills. This arrangement brings together in one mass, on each side of the center, three 4½ by 9-inch sills, which extend throughout the length of the car, except that, what we have termed the center sills, only extend to within 2 feet 3½ inches of the inside face of each end sill. All the sills proper are of yellow pine, and the draft timbers are of white oak and 11 feet 5 inches long, which causes them to extend well beyond the body bolster. From back to back of end sills there are made continuous 4½ by 9-inch yellow pine sills. The end sills are 6 by 12 inches in section and at the center are cut out, not only for the drawbar stem, but also for the ends of the draft timbers.

By this arrangement the only vertical bolts holding the draft timbers are those through the end sills and deadwoods. It is not necessary to enter the car to remove any of the bolts, but all of them are accessible from the outside. The space between the two intermediate sills is sufficient to permit of the entire withdrawal of the long horizontal bolts extending through the three timbers.

the lower end they are cut away so as to leave a foot 1¼ inches thick which fits into the gains in the faces of the sills. The upper end is joined to the plates in the same manner. A detail of one of the door posts is given in Fig. 3. The diagonals are of 6 by 2-inch oak and are set into iron shoes at each end. There are two white oak belt rails, each 3 by 3 inches in section. By the construction of the posts, as here shown, there are no tenons and mortises to rot, and repair or replacement of members of the side end framing can be more easily performed and with less disturbance to adjacent parts than in the common construction. It also gives more width inside of the car for a given outside width, because one inch of the side posts is outside of the sills, and the outside sheathing does not cover the post, thus the total gain being about 2 inches. The car is 8 feet 9 inches wide inside, 9 feet 3 inches wide over the sills, 9 feet 4¾ inches over the sheathing, and 9 feet 11 inches wide over the eaves.

The trucks for these cars are of the Barber type, patented by Mr. J. C. Barber, formerly Master Car Builder of the Northern Pacific Railroad. They are shown in Fig. 4. The frames are of the diamond type, and carry the springs by means of seats on the bottom arch bars between the column guides. Above the springs are caps separated from the bolster ends by rollers. The upper

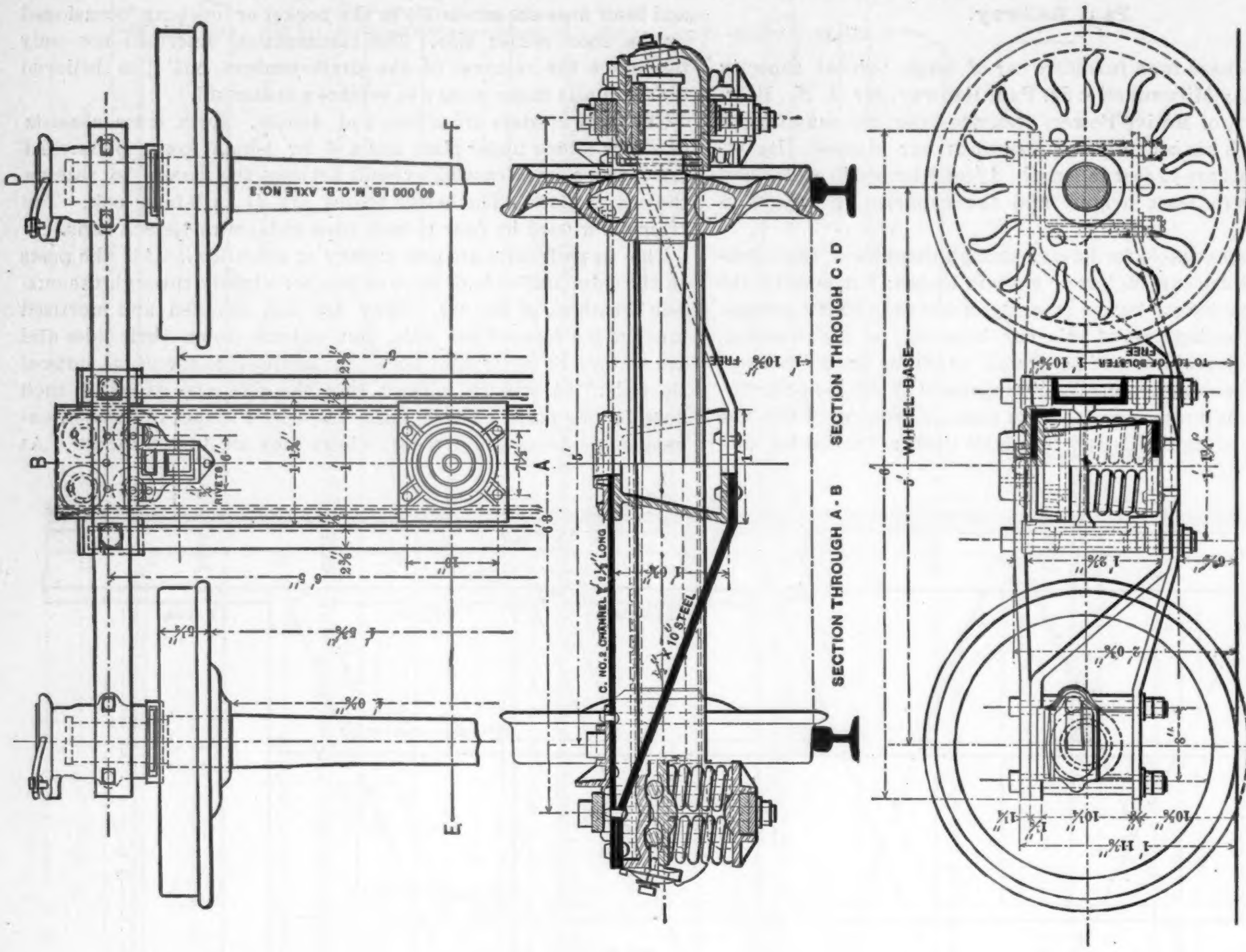


Fig. 4.—Truck for 46-Foot Furniture Car.

Chicago, Milwaukee & St. Paul Railway.

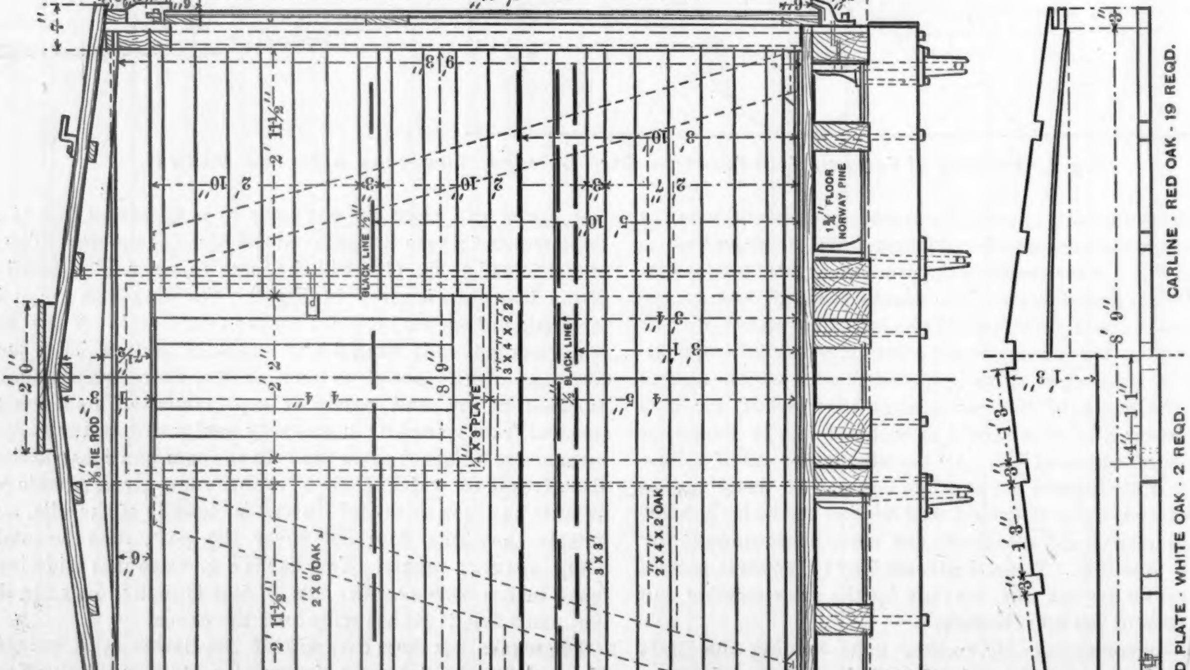


Fig. 3.—Cross-Section of Furniture Car.

During the month just passed, 31 carloads of 'scrap' were taken from the repair shop.

"This department is under the direction of C. A. Phipps, and he is ably assisted by his corps of under-foremen, and over the entire car-repair plant is Master Car Builder Benjamin Welch, upon whom the mechanics and laborers, in the fullness of their admiration, love and respect, have conferred the title 'Uncle Ben.' "

Annual Convention of the Master Car and Locomotive Painters' Association.

The twenty-seventh annual meeting of the Master Car and Locomotive Painters' Association will be held in New York City on the 9th, 10th and 11th days of September, 1896, convening at 10 o'clock A. M. on Wednesday, the 9th, at the Park (Fourth) Avenue Hotel, which has been chosen as the official headquarters of the association. The local committee of arrangements has secured a special rate of $3 per day, American plan, and those who expect to attend the convention are requested to engage rooms at an early day, stating length of time the room is wanted, and to avoid any disappointment, those engaging rooms should request the proprietors, Wm. H. Earle & Son, to send them the number and location of room.

The list of subjects to be considered is as follows:

1. The application of compressed air in burning off cars.
2. The cause and prevention of the flatting of varnish on coaches and engines.
3. Is it advisable to paint locomotive jackets, either planished iron or black steel? If so, which is the best and most economical method?
4. Essay "Painting Galvanized Iron."
5. Can a coach be painted to meet the necessary requirements with four coats of paint, or as otherwise termed, the enamel process and retain the same general appearance and durability as when painted under heretofore prevailing methods?
6. The practical painting of a locomotive.
7. Essay. Is it good policy to house passenger cars at terminals? If so, can our companies afford it?
8. Which is the best method of painting superheated parts of locomotives, viz., dome casings, cylinders, steam chests and extension fronts?
9. Which is the most economical and durable, a sandpaper or a pumice stone surfacer?
10. Spontaneous combustion in the railway paint shop. Its cause and prevention.
11. Report from Committee on Tests.

The Mileage of Chilled Cast-Iron Wheels in Freight Service.

The great improvements made in chilled iron car wheels in recent years is, in a manner, exemplified in their increased mileage. Notwithstanding the greater weights carried on them the mileage is much greater now than it was 10 or 15 years ago, and there is a good prospect that the first-class wheels put into service at the present time will maintain, if they do not add, to the reputation of such wheels.

To those who have not followed the mileage records closely there is much of interest in the following statement showing the service of chilled iron freight-car wheels on the Chicago, Milwaukee & St. Paul Railway, and kindly furnished by Mr. J. N. Barr, Superintendent of Motive Power:

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.
Office Superintendent Motive Power.
Statement showing service of freight-car wheels.

Calendar year.	No. of freight wheels m'de or bought	Freight car mileage.	Number of freight cars.	Number of freig't whe'ls in service.	Average mileage.	Average life of wheels. Years.	Mon's.	Days.
1885	22,395	215,459,302	19,402	155,216	76,968	6	11	15
1886	19,459	236,140,419	21,385	171,080	97,080	8	9	15
1887	24,721	250,774,965	21,678	173,424	81,152	7	0	1
1888	24,162	261,400,022	22,544	180,352	86,544	7	5	17
1889	26,015	250,990,286	22,776	182,208	77,184	7	0	1
1890	15,823	263,983,845	23,864	190,912	133,468	12	0	24
1891	12,810	305,482,841	25,674	205,392	190,776	16	0	12
1892	17,340	334,943,674	26,308	210,372	154,528	12	1	18
1893	17,332	312,503,242	27,963	223,612	144,240	12	10	24
1894	11,647	276,300,355	27,800	222,400	189,784	19	1	4
1895	14,219	289,316,350	27,687	221,408	162,776	15	6	26

The column headed "average mileage" is obtained by dividing the total car mileage on the road during the year by the number of wheels removed. For instance, if 10,000 wheels are in service, and 1,000 are removed each year, the average length of service would be 10 years, and the average mileage would be 10 times the yearly mileage of the cars. This, of course, does not give accurate results for any particular year, but does give a definite and correct comparison when extending over a period of years, so that the figures really show the average mileage of all wheels removed for any cause whatever.

It will be noticed that in the last six years the average mileage of the wheels removed fluctuates from over 133,000 to more than 190,000, while in previous years it never reached 100,000 miles. Another striking feature of the table is the sudden rise in average mileage between the years 1889 and 1890. This we are not able to explain fully, but it might be stated as in part explaining the sudden rise and the higher average mileage after 1890 than before that date that since the date mentioned a very large percentage of the wheels in service were cast in contracting chills. But whatever may be the cause or causes which have operated to increase the average mileage of cast-iron wheels, the result is most gratifying and is not confined to any one road. The figures speak well for the continued use of such wheels under the constantly-increasing freight loads.

It doubtless will be a surprise to many to know that the average life of a good cast-iron wheel in freight service is more than 15 years and that some of them even run for 20 years. Yet such is the fact and more than one road can testify to it. In a discussion at the recent M. C. B. convention one member mentioned this long life of cast-iron wheels, and doubtless others could furnish additional evidence of their durability.

The Introduction of Our Engineering Practice in the South American Republics.

In the last ten or fifteen years several spasmodic attempts have been made by American manufacturers to build up a foreign trade in their products, and signs are not wanting at present of a greater, more widespread, and (what is of greater significance) a decidedly more systematic effort that is being exerted in this direction. The organization of a national association of manufacturers, one of whose objects is to further the foreign trade in American manufactures, and the visit of a committee of its leading members to South America to look over the field there, are indications of the interest which manufacturers in this country are taking in foreign markets.

Another important project and one that should command the attention of manufacturers of all kinds of railway supplies, machinery, machine tools and materials for the construction of roads, docks, bridges, buildings, etc., is that which the well-known firm of Flint, Eddy & Company, of New York, are now undertaking. This firm has been engaged for years in the introduction of constructive materials made in the United States into the other countries on the American Continent, and some of the largest orders placed in this country by South American parties have been given through their agency and largely as a result of their well-directed efforts. Believing that the time has come when a larger part of the trade with these countries can be obtained by reliable firms in the United States, they are preparing to represent a greater number of manufacturers and builders of all kinds of machinery and engineering supplies, and expect to place in the hands of possible purchasers an amount of information about machinery and materials obtainable here, that will facilitate and increase the business with this country.

One of the methods to be employed in presenting this information to foreign purchasers is the publication of a book of information, copies of which will be distributed among mechanical and civil engineers in responsible positions, managers of important enterprises and others who are or may soon become purchasers of machinery or material. This valuable work is now being compiled and will contain fully one thousand pages about 9 inches by 12 inches in size. The reading matter on each page will be arranged in three columns, one in Spanish, one in Portuguese and the other in English. The scope of the work can be judged from the general divisions under which the information is grouped, which are as follows: Railroads, Lake and River Navigation, Public Works, Electrical Appliances, Special Industries (which will prin-

cipally comprise ice-making machinery and sugar-making machinery). These general divisions are sub-divided until they include in systematic arrangement everything needed in the construction, operation and maintenance of works, structures or industries suggested in the general divisions of the book.

The information given in each case will, as far as possible, consist in specifications of materials, descriptions and illustrations of machinery, advantages of same, prices, weights assembled, weights as packed for shipment, etc., all weights and measurements given in both the English and metric systems, and the whole so arranged as to give the reader an accurate knowledge of what is obtainable in the markets of the United States, as well as furnishing him an outline of the best practice in this country. A person consulting the book will thus be able in many cases to place his order without a disheartening amount of correspondence and cabling for information, with its attendant delay and expense. As the book illustrates and describes only the best, it will also be a testimonial to the excellence of American manufactures, and being printed in a language the intending purchaser can understand, should help him wonderfully and should open the way for a profitable and satisfactory business.

The compilation of this book is in charge of Mr. Emilio Del Monte, a civil engineer, who has spent much time in Cuba and South America and is thoroughly conversant with the requirements of those for whom the book is intended, and when it is published he will go to those countries, and possibly to South Africa also, in the interests of Messrs. Flint, Eddy & Company.

That such a reliable and well-informed firm should be making such extensive preparations for an enlarged business with foreign countries certainly speaks well for the prospects of American manufacturers in those markets. Familiar as they are with all the conditions of trade in those countries, they would hardly engage in such an enterprise without every reasonable assurance of ultimate success. To those who are desirous of finding a market in the countries mentioned there is thus afforded an excellent opportunity. The firm in the course of its successful career has attained a high standard in the opinions of those with whom it has done business, and its knowledge of business methods in the countries into whose markets it enters American goods are both factors that point toward success in the present undertaking.

They manifestly need the hearty co-operation of American manufacturers and builders, and we think this will certainly be given them. Our manufacturers not only need other markets than those at home, but they realize keenly as the result of industrial events in this country during the last three years that a foreign trade of considerable dimensions will help them to keep their business going with more regularity and profit than where they are dependent on the home market alone. Skilled labor and inventive genius have done so much for American industries that the result of a competition with other nations in foreign markets cannot be otherwise than successful. Messrs. Flint, Eddy & Company have offices at 66 and 68 Broad street, New York City, and will cheerfully give information to those desiring it.

It is proposed to establish iron and steel works in Japan, and the Imperial Diet has approved of an appropriation of about a million sterling for that purpose. The estimated output of the works, which are likely to be in full working order in about three years' time, is 60,000 tons per annum; which total is to be gradually increased as the works develop. The product is to be divided into 35,000 tons of Bessemer, 20,000 tons of Siemens-Martin, 4,500 tons of wrought iron, and 500 tons of crucible steel. This enterprise is being undertaken with great deliberation, and there can be little doubt of its complete success. In the near future it is probable that Japan will not only be able to supply its own wants for iron and steel, but may have a superfluity that can be shipped to other countries.—*Industries.*

The Association of Superintendents of Bridges and Buildings will hold their annual convention in Chicago, on October 20, 21 and 22, and have made arrangements with the Leland Hotel, corner of Jackson street and Michigan avenue, for the accommodation of the members.

CONSTRUCTION AND MAINTENANCE OF RAILWAY-CAR EQUIPMENT.

BY OSCAR ANTZ.

(*Continued from page 105.*)

FREIGHT TRUCKS.

One of the principal points in which American-built cars differ from those of other countries is in the manner of supporting the car-bodies on the wheels. On foreign cars the journal boxes on the axles usually work in pedestals or other contrivances attached rigidly to the car-body, thereby always keeping the centers of the axles at right angles with the center line of the car; the lost motion in the bearings and boxes and the sideplay of the wheels on the track are depended upon to allow the car to move around curves. On American-built cars the body is generally carried on two independent trucks, each of which is supported by two pairs of wheels and axles; the body is not rigidly connected to the trucks, but merely rests on them at their centers, leaving them free to adjust themselves to suit variations in the surface and line of the track.

The trucks are without doubt the most important part of a car when its safe running on the track is considered, and as certain parts of them are subjected to considerable wear, even in ordinary service, it is of the utmost importance to have these parts made so that they can be readily replaced whether on the home road or on foreign lines. This fact was recognized early in the existence of the M. C. B. Association and standards were prescribed for these parts, which have been adhered to more closely, perhaps, than any of the other M. C. B. standards.

WHEELS AND AXLES.

Naturally the wheels and axles received considerable attention. While it would hardly be policy to recommend an absolute standard for a wheel, still the diameter of 33 inches is now almost all over this country recognized as the proper size of a freight-car wheel; the shape of the tread or part which rests on the rail, the thickness and shape of the flange, as well as the location of the wheels when mounted on the axle, have been adopted as standards.

Freight-car wheels are usually made of cast iron of the so-called double-plate type, with a chilled tread, and specifications have been drawn up for these, which are recommended by the M. C. B. Association as good practice, as they are based on the results of many experiments and deductions obtained from practice. The usual weight of a cast wheel for cars of 60,000 pounds capacity is about 600 pounds. Wheels of other material than cast iron are used somewhat, but to no large extent in freight service—these wheels generally being provided with independent tires of steel.

Two sizes of axles have been adopted, one for cars of 40,000 to 50,000 pounds capacity, and one for those of 60,000 pounds. The length between centers of journals is the same in both, viz., 6 feet 3 inches; the size of the journal of the smaller one is 3¾ inches diameter and 7 inches long, that of the larger one 4¼ inches diameter and 8 inches long, the other parts of the axles being in proportion. The weights are about 400 pounds for the smaller one and 500 pounds for the larger.

Attempts have been made in recent years to increase the size of of the smaller journal to 4 inches in diameter, but this change has not been officially adopted.

The sizes of an axle and other parts of the running gear for cars of 80,000 pounds capacity are at present under consideration by the association.

Axles are made of both wrought iron and steel and each metal has numerous advocates, and it would be presumptuous to say that either is the better metal. Steel of a good quality is perhaps the stronger and is less liable to have inherent defects in the shape of hard spots, seams, etc., but it is the experience of many roads that steel axles are more liable to heat and occasionally break without apparent cause.

JOURNAL BOX AND CONTAINED PARTS.

The journal box and contained parts, viz., journal bearing and

key, for both sizes of journal, and also the general outline of a journal box-lid which answers for both sizes of box, have been adopted as standards; as all of these parts, as well as the wheels and axles are published each year in the Proceedings of the M. C. B. Association, they will not be reproduced here.

RIGID TRUCKS.

The distinctive American truck is the diamond truck, so-called from the shape of the framework connecting the two journal boxes on the corresponding ends of the two axles of the truck. There are two of these frames connected together by a crossframe which supports the bolster on which the car-body rests. The bolster rests on top of springs which are either supported directly by the crossframe, thereby allowing no lateral motion of the bolster with respect to the truck frame, or else the springs rest on

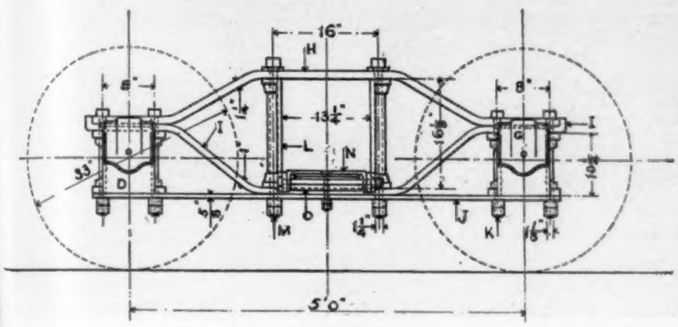


Fig. 39.

a platform which is suspended by hangers from the crossframe. and allows a certain amount of lateral motion of the bolster, This difference gives us two distinct styles of trucks, the so-called rigid and the swing-motion.

Rigid trucks are now almost universally used under heavy cars in this country, as their construction is stronger and their first cost and maintenance are less than with the swing motion style; a large part of the lighter cars also use this style of truck, of a lighter construction. Trucks of other than the diamond style have been under freight cars, and since the introduction of pressed steel in car construction several new types have been put on the market, which will be considered later.

Figs. 39, 40 and 41 represent a rigid diamond truck, which can be considered as a good example of modern practice, the bolsters and springs being omitted, as these will be shown by themselves.

The wheels *AA* are mounted by means of hydraulic pressure on the axles *BB*, the journals on the ends of these run in journal bearings *CC*, which are held in the journal boxes *DD* by the keys *EE*. The journal is lubricated by oil or grease held in suspension by wool or cotton waste, with which the lower part of the journal box is filled; wooden dust guards *FF*, which are inserted in a slot in the back of the box, and covers *GG* on the front prevent dust

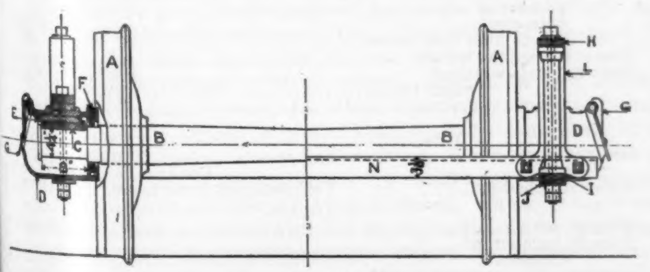


Fig. 41.

rising from the roadbed from entering the box and causing the journals to heat.

Connecting the journal boxes on each side of the truck are the archbars *HH*, the inverted archbars *II* and the tie bars *JJ*, all of which are secured to each box by two 1¼-inch journal box bolts *KK*. These bolts, as well as all the other bolts of the truck, should be provided with double nuts or some other means of securing the nuts against working off the bolts, which they are very liable to do on account of the constant jar. The inverted archbar is turned up at its ends, forming lugs against which the upper archbar is fitted. Archbars vary more or less in cross-section, and attempts to have them standardized by the Master Car Builders' Association have not been successful. The width of 4 inches is generally adopted for 60,000-pound cars, but the thicknesses vary; those shown can be considered good practice. The wheel base or distance between centers of axles is generally 5 feet or 5 feet 2 inches.

To obtain trucks of various heights from rail to center-plate, with as few changes as possible, such as would be desirable for the sake of adhering as nearly as possible to one standard, on a road having cars which vary in the vertical distance from center-plate to drawbar center, the offset of the archbars can be varied to suit these heights, the total distance at the center being always the same; and this can be done without making any other changes whatever. This is done to quite some extent in practice, there being cases in which the upper arch-bar is made entirely straight, and others where the tie-bar is arched up at the center.

Separating the upper and the inverted arch-bars near their centers are the two column guides *LL* which are secured to the arch-bars by the 1¼-inch column bolts *MM*, and to the spring plank by two ¾-inch bolts passing through both columns and through the spring plank. Column bolts should be made with a fillet under the head, and to avoid counterboring the arch-bar for this fillet, which would weaken the bar, a thin malleable washer can be placed under the head with the space for the fillet cast in it. The column guides preserve the distance between the arch-bars and also act as guides for the truck bolster, and prevent it from moving laterally, leaving it free to move vertically.

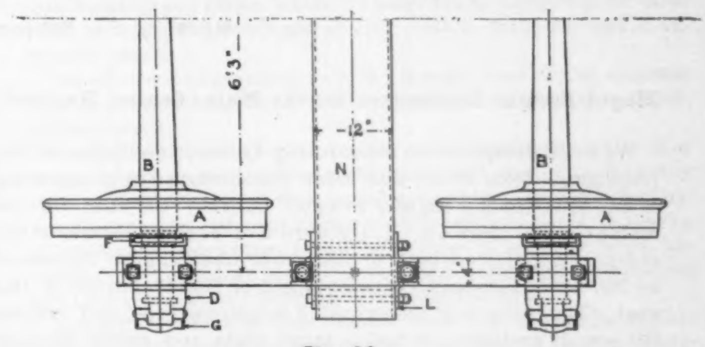
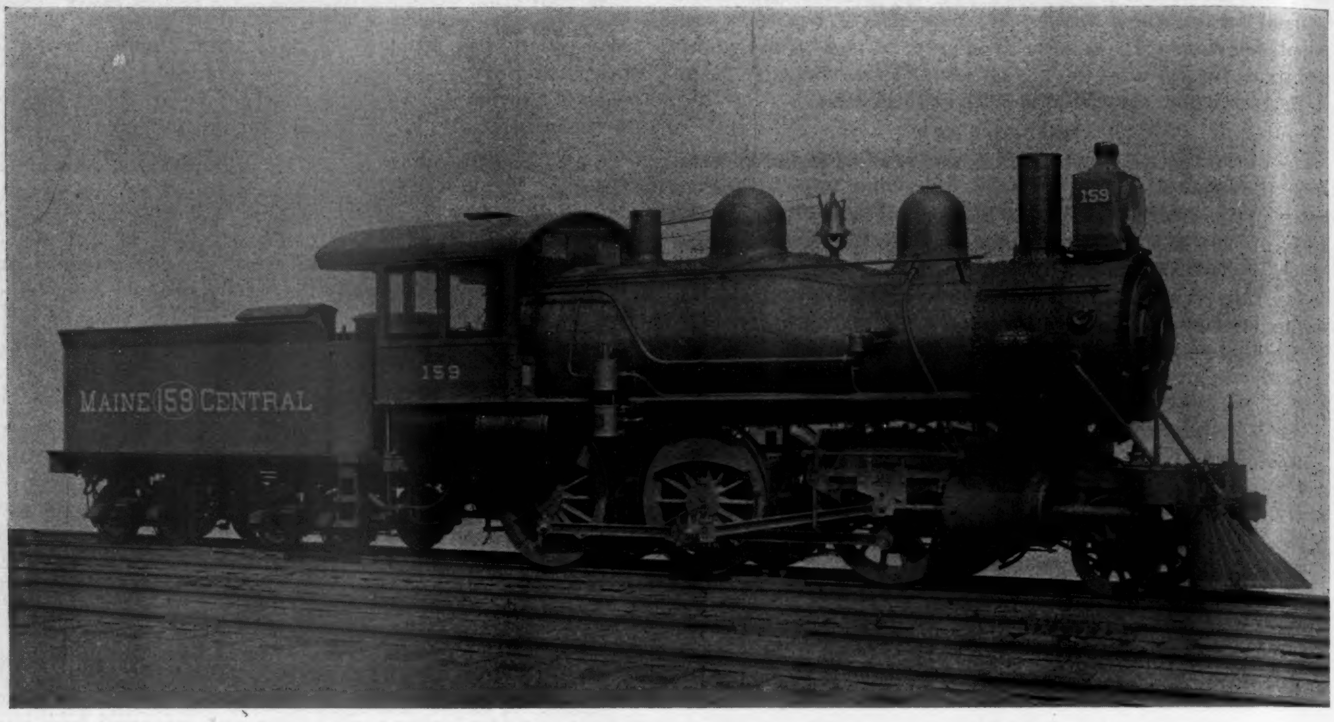


Fig. 40.

The spring plank *NN* connects the arch bars of the two sides of the truck and is bolted to the column guides by the two ¾ inch bolts mentioned and also to the lower arch and tie bars by one ¾ inch bolt, a casting *OO* being introduced to fill up the space between the flanges when a channel bar is used with the flanges turned down. The spring plank acts as the support for the bolster springs, and in the earlier cars was made of wood, hence its name. Spring planks are now usually made of channel bars, the one shown being 12 inches wide. There is no common custom in placing the bars, in regard to having the flanges up or down, both methods being practiced, and there is probably very little difference in the end. Spring planks have recently been made of pressed steel of the general shape of the channel bar.

The weight of the metal in the trucks of an ordinary freight car is far in excess of the weight of all the balance of the metal in the car, and attempts have been made of late to reduce this weight to some extent. This is accomplished by making the castings of malleable iron, instead of cast iron, whereby they can be lightened up probably one-half, and as the cost of malleable iron is about twice that of cast iron, the cost of the car is not materially increased. Pressed steel is also used somewhat for certain parts, whereby they can be lightened even more yet.

In the rotating tests of cylindrical shafts conducted at the Watertown Arsenal it is said that all steels as yet experimented with have failed under a fiber stress not exceeding 40,000 pounds per square inch, with a total number of repetitions of from four to seven millions for high steels.



Mogul Freight Locomotive With 20 by 26-Inch Cylinders—Maine Central Railroad.

Built by the Schenectady Locomotive Works.

Mogul Freight Locomotive for the Maine Central Railroad.

We are indebted to the Schenectady Locomotive Works for the photograph from which was made the accompanying engraving of one of the mogul engines recently built by the firm for the Maine Central Railroad. There were five of these engines in the order, and they were built to conform to specifications furnished by Mr. Amos Pillsbury, Superintendent of Motive Power of the road. The boiler is of the extended wagon-top type, and carries 190 pounds pressure. It has a large grate and ample heating surface, and is proving to be an excellent steamer. The engine has the full deck common to the ordinary eight-wheeled engine, thus securing a convenient arrangement of levers and valves in the cab—a matter which the men appreciate. The pistons have their rods extended through the front cylinder heads, a practice that is gaining in favor, as it is found that the saving in wear in the cylinders of large engines is considerable. The engines have 63 inch driving wheels, and 20 by 26-inch cylinders, proportions which will make a satisfactory and economical freight engine. The use of comparatively large drivers on freight engines is a move in the right direction.

From the specifications we take the following particulars:

General Dimensions.

Gage	4 feet 8½ inches
Fuel	Bituminous coal
Weight in working order	136,600 pounds
" on drivers	117,600 pounds
Wheel base, driving	14 feet 6 inches
" " rigid	14 feet 6 inches
" " Total	22 feet 3 inches

Cylinders.

Diam. of cylinders	20 inches
Stroke of piston	26 inches
Diam. of piston rod	3¼ inches
Kind " " packing	Dunbar
" " " rod packing	U. S. Metallic
Size of steam ports	18 inches by 1¼ inches
" " exhaust "	18 inches by 3 inches
" " bridges "	1¼ inches

Valves.

Kind of slide valves	Richardson balanced
Greatest travel of slide valves	5½ inches
Outside lap " " "	¾ inches
Inside " " " "	$\frac{1}{32}$ inch
Lead of valves in full gear	$\frac{1}{16}$ inch
Kind of valve stem packing	U. S. Metallic

Wheels, Etc.

Diameter of driving wheels outside of tire	63 inches
Driving box material	Steeled cast iron
Diameter and length of driving journals	8½ inches diameter by 11 inches
" " " " main crank pin journals	6 inches diameter by 6 inches
" " " " side rod crank pin journals	Main 6½ inches diameter by 5¼ inches F. & B. 4½ inches diameter by 3¾ inches.
Engine truck, kind	Two-wheel, swing bolster
" " journals	6 inches diameter by 10 inches
Diameter of engine truck wheels	33 "
Kind " " " "	Krupp No. 3 wheel. Tire 3⅛ inches by 5½ inches, held by retaining rings.

Boiler.

Style	Extended wagon top
Outside diameter of first ring	62⅛ inches
Working pressure	190 pounds
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	½ inch, $\frac{9}{16}$ inch, ⅝ inch, $\frac{11}{16}$ inch and $\frac{7}{16}$ inch
Horizontal seams	Butt-joint, sextuple riveted, with welt strip inside and outside.
Circumferential seams	Double riveted
Firebox, length	96$\frac{3}{16}$ inches
" width	40⅝ "
Firebox, material	Carbon steel
" plates, thickness.	Sides, $\frac{5}{16}$ inch; back, $\frac{5}{16}$ inch; crown, ⅜ inch; tube sheet, ½ inch
" water space	Front, 4 inches; sides, 3½ inches; back, 4 inches
" crown staying	Radial stays, 1 inch diameter
" staybolts	Taylor iron, ⅞ inch and 1 " "
Tubes, material	Charcoal iron, No. 12 W. G.
" number of	320
" diameter	2 inches
" length over tube sheets	12 feet
Fire brick, supported on	Water tubes
Heating surface, tubes	1,996.64 square feet
" " water tubes	20.51 " "
" " firebox	155.03 " "
" " Total	2,172.18 " "
Grate "	26.96 " "
" style	Rocking, with dump plates
Boiler supplied by	Two Hancock inspirators, Type D., No. 9

Tender.

Weight, empty	37,800 pounds
Wheels, number of	8
" diameter	33 inches
Journals, diameter and length	4½ inches diameter by 8 inches
Wheel base	14 feet 6 inches
Tender frame	6½ inches by 4 inches by ¾ inch angle iron
" trucks	4-wheel, channel iron, M. C. style
Water capacity	4,000 U. S. gallons
Coal "	8 (2,000 pounds) tons
Total wheel base of engine and tender	47 feet 7½ inches
" length " " " "	56 feet 5⅝ inches

The engines are fitted with the Westinghouse-American brake on all drivers, tender and for train, two 3-inch Ashton safety valves—one muffled and one open pop, Asbestos cement boiler lagging, Trojan coupler on pilot and rear of tender, National Hollow Brake Beams, with Lappin flanged shoes, and No. 3 Crosby 6-inch Chime whistle.

The engines have been in service long enough to demonstrate that their operation is excellent and that they are very light on fuel.

Transmission and Application of Power to Machine Tools.*

The years 1866 to 1873 saw a large number of stationary riveters successfully introduced, and the success of the hydraulic system firmly established. Flanging and stamping presses and hydraulic shears were also introduced in considerable numbers during this period. In 1871 the portable riveter was designed and patented by the author. The manufacture of this entirely novel type of machine tool was, however, declined by several engineers, including those who had been so successful with his stationary machines, as visionary and impracticable. The author was at last fortunate enough to secure the co-operation of Mr. James Platt, a Lancashire engineer, established at Gloucester in partnership with Mr. Fielding. They undertook to make it. It is quite certain, however, that neither the author nor Mr. Platt had any idea of the troubles in store for them. The difficulties were not so much due to its special hydraulic features as to the difficulty at that time in obtaining suitable steel for the arms, getting sufficient rigidity, combined with lightness, and arranging all the various connections to lead the water from the accumulator to the porrtable riveters suspended many feet in mid-air. However, in 1873, the Primrose Street Bridge, over the Great Eastern Railway, London, was completed, being the first bridge mechanically riveted in *situ*. Just as most of the initial difficulties were surmounted Mr. Fielding died, and in the many new designs and applications introduced and patented since then, his son, Mr. John Fielding, has been closely identified.

But if 1873 was an important epoch in hydraulic riveting, the year 1878 afforded the first opportunity of fully showing the economical advantage of the hydraulic system as a means of transmitting power to machines of many different kinds spread out over great distances. In consequence of the author's representation, and the assistance of his colleague, Mr. Henry Chapman, of Paris, Mons. Marc Berrier-Fontaine, the engineer of the French arsenal at Toulon, authorized the laying out of the whole of their new works on the author's hydraulic system; the machinery being supplied by the Hydraulic Engineering Company, of Chester, and Messrs. Fielding & Platt, of Gloucester, and from that time the hydraulic system of machine tools was firmly established, and occupies in its proper field an unassailable position by reason of its economy and convenience of application.

There were two causes some 25 or 30 years ago which assisted the introduction of the hydraulic system for special classes of machine tools—first, the increasing size and scantling of all boilers, bridge and ship work, and second, the increased areas thereby covered by the works themselves. So long as hydraulic power is confined to work of a more or less reciprocating character (with the one exception of capstans), there is no other system comparable with it on the score of economy, but when we come to driving lathes, planers, spread over large areas, electrical power comes in on the ground of the convenient way in which it can be transmitted over great distances, and the suitability of its motors for rotary work. Always bearing in mind that their suitability for the work to be done is ascertained, it may be stated that for transmitting and applying power over great distances, water and electricity have both their special advantages. Electric transmission, if more costly, is on the other hand very conveniently applied at different points; traveling cranes may be cited as one of the best applications.

So far as the relative economy of hydraulic power, shafts and belting or electricity are comparable, it is easier to compare shafting with electricity than either of these with hydraulic power. In the case of the former, given an equally economical and efficient prime mover, for all reasonable distances, it resolves itself into a question of the interest on cost of shafting only, or on that of dynamo, with its leads, motors and shafting. When the distances become greater we can then compare the relative cost and advantages of hydraulic and electrical transmission. In many cases even this comparison is not possible, for the operation to be performed by the hydraulic machines and those driven by electricity are in many cases essentially different. Many of the heaviest operations done by hydraulic tools only occupy so short a time that a large reserve of power must be stored up to render them practicable. For reasons of cost this is not possible with electricity, but in the hydraulic system, perhaps, the most important feature is the accumulator, and it constitutes the most important factor in its economical success. We may at once eliminate this feature in an electric system on account of its present great cost, and, of course, in transmitting power by shafting or ropes it is also impossible; and it can only be adopted to a limited extent in pneumatic transmission.

In the case of transmission by shafting or electricity, the prime mover must be large enough to meet such demands when they occur, but in the hydraulic system, not only is the prime mover not required to be equal to the greatest efforts (only occasionally required), but on the other hand the size of the prime mover can be very much reduced; for the accumulator allows of the smaller engine being kept more or less continuously running and storing up power during the very considerable intervals when only a portion of the machines are at work.

This question of the proportion of machines absolutely engaged "tooling" and those standing idle while work is being taken to or from them, or from other causes, is not a new one. The author alluded to this in a paper read by him in 1886, and gave some figures based on data published by Mr. William Hartnell. It may not be amiss to draw attention to the very considerable mechanical, if only occasional, work done in hydraulic machine tools with prime movers of almost pigmy proportions. In our youthful days the raising of the Conway Bridge tubes was always cited as an instance of a great effort. Well, the best they did was lifting 1,300 tons 13 feet in 60 minutes, or 282 foot-tons per minute. The ordinary 150 tons riveting machine will make four strokes per minute of 6-inch each = 300 foot-tons per minute, but the mechanical effort is really more, for these two feet are really done in little over 20 seconds, the remaining 40 seconds being required for the return stroke of the ram. If such a machine had to be driven by shafting or electricity, in the first instance the prime mover must be equal to exerting this 300 tons in 20 seconds plus friction of shifting; and in the case of electric transmission the prime mover must be the same plus the losses incidental to the dynamo, the cables and the electric motor gearing between it and the machine. We will leave it to others to minimize or fix these losses, but we know that in the case of pumps and accumulators and mains, which we may take as occupying the same place as the dyamo, leads and electric motor, that the loss is extremely small.

The efficiency of good pumps is 78 per cent., that of the accumulator 91 per cent., and the loss in properly designed mains is extremely small.

Coming now to the machine tools to be worked by the water thus transmitted: It is, of course, understood that generally speaking we are only discussing, this evening, machines suitable for hydraulic pressure, either by reason of their being required to exert a great force during a short period, or to exert in addition more numerous efforts (such as punching, shearing or riveting) at distances from the prime mover beyond the reach of shafting.

In the former case we have shown that the hydraulic system alone meets the case, and for great efforts, such as forging, flanging, etc., the same applies. But in smaller machines there is more room for divergent opinions.

This brings us to the consideration of the suitability of hydraulic pressure for punching and similar machinery, placed about large ship and bridge yards. We have lately seen some startling instances, from an electrical standpoint, of the wastefulness of this class of machine driven by separate steam engines, all of which was pointed out by the author 24 years ago, in many technical journals and papers, with the view of substituting hydraulic machines.

Electricity as a motive power for moderate sized machines in frequent work certainly seems to fulfil most of the conditions, but it cannot claim to have all its own way. The machine has to wait till the speed of the motor is got up, and a similar loss of time and power ensues when the machine is being stopped, whereas in the hydraulic machine it is only consuming power while work is being done. There are, of course, losses peculiar to the hydraulic system, and there are climatic considerations to be considered, and the final verdict as to the power selected can only be the result of experience and judgment brought to bear on each particular case.

In many classes of work it is essential that the exact pressure exerted be known, and that the same pressure be exerted every time it is applied under similar conditions. This is the case more especially in riveting. In the case of riveting, as is well known, the length of rivets, when finally closed, is more or less a varying one, owing to the temperature, number of thicknesses of plates, etc. The hydraulic ram can be made of sufficient stroke to do the shortest or the longest, and at the end in every case exert the same final pressure. We have in this a very important advantage—only obtainable in hydraulic machines. This range of travel is one of the chief advantages of all hydraulic machines, and is practically unobtainable in geared machines, whether driven by shafting or electric motors.

* Part of a paper written by the late M. R. H. Tweddell and read January 25, 1896, before the Manchester Association of Engineers.

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CONTENTS.

The notification by the Postmaster-General that the law would be enforced forbidding the transportation of letters or other written papers on railroad trains unless postage is paid on them, was a knockout-out blow at the "R. R. B." letters. The action of the railroads under the notification has not been uniform. Some have abandoned "R. R. B." mail entirely, while a number of large companies have issued orders that the correspondence sent by "R. R. B." mail shall only be such as pertains to the business of the company and destined to points on its road. In other words they hold by this action that the exchange of railway mail between railroads may be rightfully stopped by the postal authorities, but that their right to transport their own letters in their own cars to points on their own line cannot be taken from them, the law to the contrary notwithstanding. The law as it stands appears to be with the Postmaster-General, but if pressed far enough it is believed that it would be declared unconstitutional, in-so-far as it prevents railways carrying their own mail between points on their own lines.

The use of compressed air in railroad shops, which has made such progress of late, did not originate in recent years. We are informed that in 1879 the first air motor to be used in the Missouri Pacific shops was made and put in operation in the St. Louis shops of that road. It is claimed that this was the first railroad shop to use compressed air in running small tools and doing other work which otherwise had been done by belt-driven machinery. As early as December, 1882, there appeared in the NATIONAL CAR BUILDER, an article on these shops in which the following reference was made to the use of compressed air: "These shops have in use a portable drilling machine driven by a three-cylinder Brotherhood engine supplied with air from two Westinghouse pumps. These engines are quite small, are mounted on wheels, and are also used for driving staybolt taps, portable cylinder-boring machine and valve-facing machine. They were designed by Mr. Hewitt, the superintendent of machinery, aided by his assistant, Mr. Leroy Bartlett. Inasmuch as they can be taken to any place in the shop and applied to almost any kind of work, taking the place of handwork in many cases, it is a little surprising that such machines are not more generally used." Thus, as far back as 1882, we find the advantages of compressed air clearly stated and the practice of one road cited in a way that shows its officials had applied it to many of the uses to which it is now put. Why others should have been so slow to take it up is not clear, but whatever the reason the rate at which it has been adopted in the last few years shows that at present it is appreciated.

A contemporary publishes in a recent issue a description of an air compressor being built at Bridgeport by a company whose object seems to be much the same as that in view by the free silverites in the present political campaign—they want to get something for nothing. They are persuading themselves that a 140 horse-power steam engine will turn an 82-foot wheel and develop 2,500 horse-power at the rim. The 82-foot wheel carries ten groups of wheels, three in a group, each wheel weighing 4½ tons. These wheels, as the large one revolves, operate cam levers connected with the pistons of 100 compound air compressors with 16-inch by 12-inch intake cylinders, secured to a fixed circular track under the wheel. The mechanism thus consists of 204 pistons, one 82-foot wheel, thirty 9-foot wheels, 50 cam levers, numerous gears, etc., etc., while eight single compound compressors with 32-inch by 36-inch cylinders would compress a like amount of air. But this extra mechanism is as nothing compared with the power to be *created* by it, which is 2,500 — 140 = 2,360 horse power, which, if worth $30 per year per horse-power, amounts to $70,800 per annum. This, you see, is clear gain. But why don't the promoters dispense with the machinery and use the 140 horse-power engine alone? All they need do is pronounce its output to be 2,500 horse power instead of 140 horse power, and then rake in the $70,800 per year. That is what we are asked to do with the silver dollar—just announce that its 53 cents are not 53 cents but exactly 100 cents, and lo! it

will be so. The simplicity of such a proceeding makes it far superior to using hundreds of tons of machinery to raise 140 horse-power to 2,500 horse-power.

The illness of two of the engineer officers of the United States battleship *Indiana*, Chief Engineer George E. Tower and Passed Assistant Engineer A. McAllister, during the manœuvers of the Atlantic squadron last month, is a forceful illustration of the need of an increase in the engineering branch of the navy. The modern battleship is an immense aggregation of machinery—machinery everywhere and for everything, and that the large amount of skilled labor and of mental energy necessary to keep it in good condition at all times, is not realized or is deliberately ignored and the lives of officers thereby jeopardized, is a disgrace. The cruiser *Columbia*, with 90 engines, 172 steam cylinders, and all its varied and complicated machinery, has only four engineers. Is it any wonder the engineers are unable to stand the strain? There are to-day four line officers to one engineer in the navy, and yet the line officers are actively opposing any increase in numbers or authority of the engineers. And so after eight days of peaceful manœuvering the efficiency of the most powerful battleship of the navy is for the time impaired by the temporary loss of one-half of its engineering staff. What would be the condition of affairs in case of war if peace manœuvers are so disastrous? Who is going to assume the responsibility for this condition of affairs? It is to be feared that when the citizens of this nation finally awaken to a realization of what is going on they will refuse to believe that anything approaching patriotism and the good of the service has been the actuating motive of line officers, and these officials will then lose more of their prestige than if they now used their influence to promote needed reforms. The more the pendulum is held to one side of the normal the further it will go to the other side when once it is liberated.

The economy in the direct application of the power of a steam engine to the work to be done is generally conceded, and the magnitude of the saving thereby effected is well illustrated by the power required for driving the "jack shafts," so common in electric installations a few years ago. In the power station of the Elmira Illuminating Company, of Elmira, New York, there is a jack shaft 136 feet long by $5\frac{5}{16}$ and $6\frac{5}{16}$ inches in diameter. To this shaft are belted five steam engines, three of which are of 300 horse power each, and one of 500 horse power, and a number of dynamos, the shaft having 20-clutch couplings, so as to use any desired combination of engines and dynamos. The horse power required to drive this shaft was 83.2, and in a recent test of the 500 horse-power engine recorded in a paper before the American Society of Mechanical Engineers, the percentage of the total engine power consumed by this shaft varied from 16.6 per cent. under a full engine load to from 30 to 45 per cent. under the light loads. This indicates one of the advantages obtained in the direct connected engines and dynamos now almost universally installed in such stations, and is also suggestive of the economies which can be obtained by a judicious rearrangement of line shafting in shops, by which much of it will be dispensed with and the tools driven singly or in groups by electric motors.

A contemporary in giving the general results of the tests which a certain railroad is making with the simple and compound mogul engines built at its shops, states correctly that the various kinds of compounds do not differ much from each other in economy, and average about 15 per cent. less coal than the simple moguls. It then makes the statement that these compounds compared with a class of consolidations pull 15 per cent. more load and do the work on less than half the fuel. This is one of those sweeping statements that won't bear investigation. To illustrate: If we take "less than half the fuel" at 45 per cent. and do 15 per cent. more work with it, the result is the same as if the same amount of work had been done with 39 per cent. of the fuel used by the consolidation engines. Now, either the compounds are marvels, the consolidations of shockingly bad design, or the statement of performance untrue. The probability is that the trouble is with the statement. A large saving ought to be expected from three causes—the compounding, the use of relatively large drivers and the elimination of one pair of drivers, but as the compounding is only credited with 15 per cent., railroad men will be slow to believe that 46 per cent. saving is obtainable by using a mogul with 62-inch drivers in place of a consolidation engine with much smaller wheels. And yet, while the magnitude of the saving may not be as much as is claimed in such careless statements, the experience of the last few years is leading to better and more economical designs of freight engines. Large drivers were in disfavor for years because they were usually accompanied by small cylinders, and the combination did not succeed in producing the required tractive effort. Three and four pairs of driving wheels with moderate weights on them were used because track and bridges would not permit of heavy weights per wheel and because it was feared that tires and rail heads could not endure heavier loads without rapid flow of the metal and consequent destruction to both. Now we know better and the conditions on many roads have changed. Loads as high as 46,000 pounds per pair of wheels are believed to cause no damage to large tires or to heavy rails, and modern track and bridges are considered safe under such loads. Consequently, with the higher wheel loads permissible, a weight formerly put on four pair of wheels can now be carried on three pairs, and the weight that used to be the maximum for three pairs is now readily carried on two. The internal friction of the engine and the number of moving parts is thus reduced, with economy as the result. The higher steam pressures and larger boilers and cylinders now used in combination with relatively large drivers for freight engines, have made the large drivers a success. Their use has likewise resulted in economy through reduced piston speed and less friction, and the smaller cost of repairs. That these facts are realized by the mechanical departments of railroads is evident from the present tendency toward larger drivers and fewer of them for freight engines, the consolidation type when used being justified by a great weight on the drivers. But while the saving in wear and tear and in fuel justify these reforms, the fuel saving cannot reach 46 per cent., for the simple reason that the total loss from these causes was not that much.

THERMAL TESTS OF CAR WHEELS.

A correspondent, who modestly asks that his name be not used in connection therewith, has sent us an account of some interesting tests which he made of car wheels, after reading the article in our June number describing the experiments which were made in Altoona. The heat he says which was applied by the tests was in excess of anything possible from the application of brakes. A band of molten metal 1¼ inches thick by 4 inches

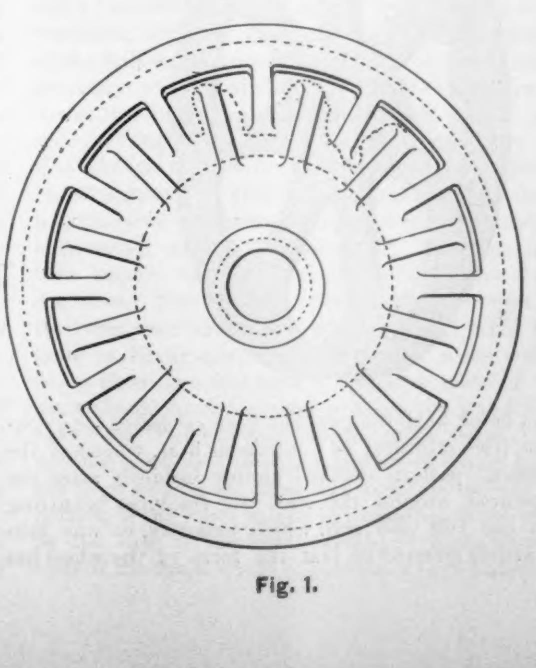


Fig. 1.

Fig. 2.

deep was poured around the rims as in the Albina tests. If the wheels were removed at once, as soon as the molten metal was set, the plates or brackets would not crack, but if allowed to remain any length of time they would. The wheels were 33 inches in diameter of what is called the double-plate pattern shown in Figs. 1 and 2. The brackets or ribs on the back of the wheel were arranged as shown in Fig. 1; that is, each alternate bracket extended from the rim inward, and those between extended from the inner plate outward as shown in Fig. 2. The object of this arrangement is to relieve the strains from contraction after the wheel is cast, and it is also thorght that with ribs arranged

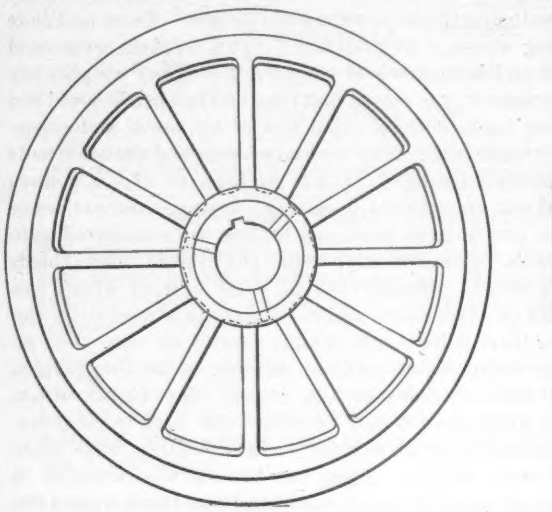


Fig. 3.

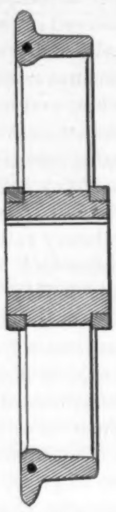
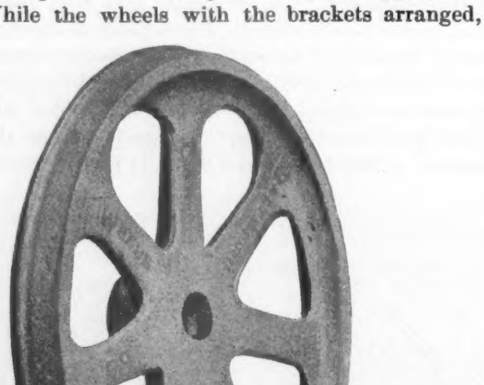


Fig. 4.

in this way wheels have greater strength to resist the strains to which they are subjected in service.

In the tests which were made this form of wheel did not crack until two minutes after the metal was poured around it, and, as has been stated, if they were removed from the band of molten metal immediately after it was poured, neither the plates nor the ribs were broken. The form of the crack was peculiar, and is represented by the dotted line in Fig. 1, and, as will be seen, it did not extend across any of the ribs or the rim, the plate only being fractured. In such tests, it is said, the rims are heated to a much higher temperature than is possible by the application of the brakes. While the wheels with the brackets arranged, as



shown, did not crack until the rims had been subjected for a considerable time (two minutes) to continuous heat, wheels of the usual "Washburn" pattern cracked almost instantly after the metal was poured around the rim, the fractures occurring through both the ribs and rim, which indicates, as was intimated in the article referred to, that the form of the wheel has an important influence in its capacity to resist such strains, and also that the ordinary "Washburn" pattern is not the best form.

In our article in the Juue issue on this subject we illustrated by an engraving made from memory a form of cast-iron wheel, which was made by Ross Winans 40 or 50 years ago, and we ventured the observation that it seemed as though a wheel made in that way would not be broken if tested in the manner described. Fortunately the experimenter who made the tests, which are the subject of this article, had one of these wheels which was made by Winans in 1840, of "Connervingo" charcoal iron, and he has sent us a drawing of it, from which Figs. 3 and 4 have been made. This wheel is 30 inches in diameter, weighs 400 pounds, and the hub was made in three parts which had slots or spaces between them which were filled with zinc. The hub was then banded on both sides with wrought-iron rings, which were shrunk on, as shown. There is also a wrought-iron ring shown in Fig. 4, and which was described in our article published in June. This ring was made of round wrought iron, ½ inch in diameter, and was cast in the wheels inside of the throat of the flange. The wheel referred to was subjected to the molten iron test, as described, without cracking. It took a minute for that to extend to the hub and two minutes to equalize through the parts of the wheel.

Experiments were also made with an ordinary open-motor-face truck wheel, Fig. 5, by placing a red-hot chill ring or band around the rim. It was allowed to remain on the wheel until it became cool (55 minutes), all the heat, excepting that which was radiated from the outside of the ring, being absorbed by the wheel casting, which was so hot at the expiration of that time that it was uncomfortable to bear the hand on it. The wheel stood the test without cracking or showing any signs of injury.

It will thus be seen that in these experiments the two spoke wheels stood the thermal test without breaking, which is additional testimony to the fact, which was suggested in the article referred to, that the capacity of cast-iron wheels to resist such tests as have been described depends very much upon the form of the wheel, which opens up the interesting inquiry, what is the best form for such wheels?

The experiments here described have great interest in the consideration of a reply to this inquiry. If it is true that spoke wheels are less liable to break than plate wheels it is an important fact and one which it would be worth while to prove by experiment

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

Notwithstanding the wonderful development of the locomotive and what it has accomplished for civilization and the welfare of mankind it must be admitted that it still has many defects, and some of us are still sangnine enough to think that it is susceptible of further improvement.

It may be said, for example, that a pound of average coal contains sufficient potential heat to evaporate about 12½ pounds of water. It will not be far out of the way to say that in ordinary practice the average evaporation is not more than half that amount of water per pound of coal, so that half of its heat escapes out of the chimney, or falls through the grate unutiliz d, or goes to waste. This waste is due partly to imperfect combustion, and partly because the heat in the products of combustion is not communicated to the water in the boiler. It is not uncommon to find a temperature of 800 degrees or more in the smokebox of a locomotive, and as the temperature of steam of 150 pounds pressure p r square inch is only 366 degrees obviously these escaping gases have a capacity for generating a great deal of steam. Besides this the exhaust steam escapes at a pressure of about 15 pounds, and carries with it a great deal of heat which does no work. This is not a new view of the wastefulness of locomotive engines. The subject of improved combustion has been under consideration ever since locomotives and steam engines have been used, and the literature of the subject is now quite beyond the hope of mastering by any one person. Experiments innumerable and inventions which cannot be counted have been made to produce more economical results in the use of coal, but it must be admitted that

the progress which is made is very slow, and the saving which is effected is very slight. One of the main lines of road during the past year or two has been equipped with appliances for weighing fuel, and since then the subject has been studied more carefully on that road than ever before, with the result that a very important saving of coal has been effected, but after years of experience and investigation the verdict of the superintendent of motive power of that line, who has had a long experience in his calling, is that the best means for reducing the consumption of fuel is to improve the firemen. This he has done by having accurate reports of what each of them is doing, and then calling them to account when an excessive amount of coal is burned and investigating whether they or the engines are the cause of it. The breeding and education of firemen will not be discussed now, but the possibility and means of effecting economy by changes and modifications of the engines themselves will be considered.

We have recently made some inquiry with reference to the form and proportions of grates, having a vague idea that some grates are probably better than others. Thus far we have obtained but little more information than that contained in the general statement that grates should be adapted to the fuel to be burned on them. One investigator on the subject stated the general principle that "in every case the widest possible opening should be used that would hold the fuel." For burning shavings and wood, he recommended spaces between the bars $\frac{7}{8}$ inch wide; for "egg" and "furnace" anthracite and coke, $\frac{3}{4}$-inch spaces; for bituminous coal, $\frac{5}{8}$-inch; for sawdust and "nut" anthracite, $\frac{1}{2}$-inch; for "pea" coal, $\frac{3}{8}$-inch. In these recommendations authorities did not agree, and the conclusions seemed to be based on the most casual observations, and were not the result of any carefully made investigation or experiments. To such inquiries as we have made, the general reply of the average master mechanic, it is believed, would be only that general statement—that grates should be adapted to the fuel to be burned in them; but when it comes to any specific statements, with reference to the adaptation, our investigations have shown that their opinions are very vague.

Now, there can be no doubt that the intimate contact of air with the fuel promotes combustion, until, as in the case of powdered fuel and coal dust, when mixed with air they burn so rapidly as to become explosives. If the lumps of coal on a fire are too large, combustion is slow and imperfect, and this is also the case if it is fine and closely packed in the grate, as then the air comes in contact with only a small portion of the surface of the fuel. If coal is pulverized into dust, and floats or is blown in a current of air, the latter comes into such intimate contact with the particles of the fuel as to make it burn, as has been said, with the rapidity of an explosion. Between these limits there is almost every degree of perfect and imperfect combustion. As every fireman who understands his business knows, if coal is broken into suitable sized lumps it can be burned much more perfectly than is possible if it is either larger or smaller. It would seem, then, that what should be aimed at in a grate is to give the air access and bring it in contact with the fuel. That grates as at present made are the best which could be adopted for effecting that end seems very doubtful. It seems quite possible to design a grate which would permit air to circulate more freely below and among the fuel than it can as these appliances are now made. At present the top surfaces of grates are made to coincide with a plane flat surface. If instead of being flat this surface were made with projections so as to have interstices below the coal for the circulation of air it would seem as though it would do something to promote combustion.

Notwithstanding the fact that the value of dead plates has often been pointed out, most locomotive grates are still made without them. Attention has been called in these pages heretofore to the fact that it is desirable in all furnaces to keep the flame out of contact with the sides and top, until the process of combustion is completed. It seems quite certain that combustion is retarded and partially arrested when flame comes in contact with any solid substance. The inference from this, therefore, would appear to be that it is desirable to keep the fire away from the sides and ends of a firebox as much as possible, which may be done by putting dead plates all around the grate so that no air will be admitted next to the sides and ends. The question of the most advantageous locality and proportions for dead plates is still a matter about which very little is known.

The most economical rate of combustion is also worthy of consideration. It probably may be either too slow or too rapid for economy, and it seems reasonable to infer that there is some rate which is more economical—at least, under given conditions—than any other. What this rate is we do not know, but as the amount of coal which must be burned in a locomotive firebox varies constantly, it would seem as though an essential for securing the highest economy would be a variable grate, or one in which the opening could be increased or diminished or in which the live and dead portions can be varied at pleasure. With such an appliance, the rate of combustion per square foot of grate could be kept uniform, or nearly so, in all conditions of working, and at the most economical rate.

In stationary boilers down-draft grates have met with a considerable degree of success. Whether they would be equally so in locomotives is of course an open question. The principle on which they operate seems to be a correct one, and there is no apparent reason why it is not applicable to locomotives as well as to stationary service.

It is, of course, true that while it is often possible to gain what is an apparent advantage, yet before it is ultimately realized it is offset by some expense or difficulty which entirely neutralizes the gain. In all such cases it is the algebraic sum alone which counts ultimately. If the + and the — quantities are equal, no matter how promising the former may be, they will be obliterated by the latter.

The attempts which have been made to save some of the heat which escapes up the chimneys of locomotives are in number almost like the efforts to achieve perpetual motion. They have generally been some form of feed-water heaters or steam superheaters. Nothing seems more plausible than a feed-water heater, and the theoretical advantages of superheating have been often shown. Nevertheless, after almost innumerable trials they have all been abandoned. The various considerations always overbalanced those with a + sign. Still, neither of them now seems to be entirely hopeless, even after a vast number of failures. It must always be kept in mind when improvements in locomotives are contemplated that they must be regarded somewhat as a farmer does a reaping machine. This must be ready and capable of cutting the harvest when it is ripe, and above all things must not break down before the work is completed. It is very much so with locomotives. There are periods of harvest time on railroads when it is of the utmost importance that freight and passenger trains should be moved. A breakdown when there is a congestion of traffic is a very serious matter. It does not make much difference how economical a locomotive may be or how well it works when it is in good condition, if it fails at the time when it is most needed, the cause of the failure, no matter whether it is or is not productive of economy, will be condemned. Feed-water heaters have come under this kind of condemnation. It is easy to prove that they will save fuel, but they are apt to prove costly in other ways. The problem is to secure their advantages without incurring the risks referred to. This it is thought might be done if the tubes of a locomotive were somewhat lengthened and their front ends were surrounded with cold feed-water. The escaping gases would thus impart more or less of the heat to the water surrounding the tubes. Now, to carry out this plan, suppose the boiler and the tubes were lengthened about two or three feet and that a plate or diaphragm, similar to a tube plate, was placed in the boiler about two feet back of the front ends of the tubes. The plate should extend upward to about the water line. If now the feed-water was delivered into the space between this diaphragm and the front tube sheet the cold water would be in contact with the front ends of the tubes and therefore more of the heat in that portion of the tubes would be imparted to the water than would be the case if the water outside of them were hot. The front ends of the tubes would thus act as a feed-water heater and there

would be no portion of it more liable to fail than the present boiler is. In other words, it would provide a feed-water heater without any of the objections which experience has shown have always attended the use of those which have heretofore been tried.

But the length of an article makes it impracticable to discuss some other features in locomotive construction which seem to be capable of improvement. The consideration of them will be reserved for a future article.

When we consider that the stationary steam plants owned and operated by railroads aggregate hundreds of thousands of horse-power, it is a matter of surprise that the members of the Master Mechanics' Association do not find some subjects in connection with them that would be worthy of discussion at its conventions. From the absence of such topics from the proceedings of the association it might be concluded that railroads believe there are no unsolved problems in connection with their stationary boiler plants and that their practice was up to date in every respect. And yet we have heard it said that there is a chance for great improvement in these very plants, and that the absence of discussion regarding them is only an indication of the indifference with which they are regarded. There may be a great deal of truth in this view of the case. Certain it is that many roads have stationary plants of such large dimensions that the types of boilers installed, the use of automatic stokers, conveyors for coal and ashes, methods of boiler setting, feed-water heaters and other kindred subjects are of considerable importance, and involve economies of no small magnitude. The mechanical department of a railway is, or should be, interested in more than locomotive practice, and a representative association of this class of men might profitably devote some attention to the economies obtainable either by better engines, boilers and appurtenances, or by improved methods of operating the present installations.

NOTES.

The engines of the *St. Paul*, on her recent record-breaking trip, developed a horse-power of slightly more than 1¼ pounds of coal —a most excellent performance, when it is considered that it is an average for an entire trip, during which the engines and boilers were worked hard. The daily consumption of coal was 315 tons.

A French journal publishes drawings of a new method of staying the fireboxes of locomotive boilers. The bolts, instead of passing through the inner sheets, enter part way only, the sheets being thickened at the bolts by small bosses on the water side of the sheet, so as to get sufficient thread to hold the sheet. Such a construction might be possible with copper sheets, but would be of little practical value, while with steel sheets it is next to impossible.

In addition to the tests of four different two cylinder compound mogul engines, the Pennsylvania Railroad has also been measuring lately the coal and water used by Class L passenger engines and the eight-wheeled two-cylinder compound passenger built at Altoona some time ago. The compound is using considerably less fuel than other engines on the same runs. It will be remembered that this engine has 19½ and 31 × 28-inch cylinders and 12-inch piston valves.

The Holman locomotive, that marvelous engine having a pyramid of multiplying wheels between each driver and the rail, being in principle an inverted Fontaine engine, recently hauled a train of two cars at speeds between 60 and 90 miles per hour. There is nothing remarkable about this speed, except the fact that the Holman locomotive made it. The wonder is that it could make the 20 small wheels placed under the drivers spin around at this speed. We have not heard of a saving of coal from the use of the 20 additional wheels and don't expect that any will be found.

In a paper on the design and manufacture of gears, read by S. Groves, M. E., before the Engineers' Society of Western Pennsylvania, the general advantages of short gear teeth are given. The author says that in calculating the horse power of a gear the teeth are usually considered as cantilevers, liable to be broken off at their roots by lever strains. The new departure consists in so proportioning the teeth that the old lever strain was transformed into a shearing strain. To do this the length of the tooth was reduced from .7 to .5 of the pitch, and the flanks so shaped that but one tooth was in contact at a time. These gears are found to run noiselessly and are claimed to have great advantages for large powers and service in which severe shocks are encountered.

At Ashtabula Messrs. M. A. Hanna & Company have recently put in service a coaling barge for placing fuel upon steamers while they are unloading or receiving a cargo. The hull resembles that of a big scow, is 180 feet long, 36 feet beam and contains 16 compartments capable of holding 640 tons of coal. At one end is a small set of engines for the twin screws, by which the barge is propelled about the harbor. At the other end are elevators for lifting the coal from the barge to the steamers. Under the pockets or compartments is a conveyor that delivers the coal to the boot of the elevator. The barge can approach a steamer at the dock from the harbor side and deliver the coal quickly and without interfering with the handling of the cargo.

Trial runs were lately made in Germany, between Berlin and Lubbenau on the Berlin and Gorlitz line. A German contemporary says that for these runs a special express engine of new design with four cylinders and driving wheels of two meters (6 feet 6 inches) diameter was constructed. The trains were of various lengths, amounting sometimes to 100 axles. With a train of 30 axles the highest performance, viz., 106 kilometers (65⅞ miles) per hour, was recorded, being 20 kilometers (12 miles) more than the highest speed hitherto attained by the quickest German train, viz., the Berlin-Hamburg D-Zug, which runs through a distance of 286 kilometers (177¾ miles) in 3¼ hours, while the speed of ordinary German expresses is only 70 kilometers (43½ miles) per hour. The portions of lines chosen for these runs are nearly level and have few curves.

It is said that a new road 15 miles long is proposed in Northern Michigan to carry ore to Lake Superior from the mines, and that in this distance the total grade amounts to 800 feet. The freight will be almost entirely iron ore, and the cars carrying it will return empty to the mines. It is suggested that the cars be run in trains of 10 each, each train being supplied with an electric generator, connected with the axles. The grade is such that the loaded cars would run by their own weight, and the dynamos generate a current, which could be taken off upon a trolley wire and used to haul the empty cars back. It is thought that the difference in weight of the loaded and empty cars will give power enough to overcome all leakage, friction, etc. The engineers are figuring on using the dynamos as motors on the return trip, and thus saving expensive machinery.

It was shown by M. H. Moissan, about three years ago, that when iron was saturated at 3,000 degrees C. with carbon, and then cooled under a high pressure, a portion of the carbon separated out in the form of diamond. It occured to M. Rossel, *Comptes Rendus*, July 13, that the conditions under which very hard steels are now made should also result in the formation of diamonds; and an examination of a large number of samples of such steel has shown that this is really the case. The diamonds are obtained by dissolving the metal in acid, and then subjecting the residue to the action of concentrated nitric acid, fused potassium chlorate, hydrofluoric and sulphuric acid successively. The crystals are very minute—the largest attaining only 0.5 millimeters in diameter, but *Nature* says they present all the chemical and physical properties of true diamonds.

In a paper by Mr. Price Williams, written to prove that the terminal charges admissible by the British Board of Trade railway rate schedules were inadequate, he quotes traffic statistics from the London & Northwestern Railway to show the large proportion of receipts absorbed for station or terminal charges. The

cost of running passenger trains is given as 2s. 5½d. per train-mile, of which 11¼d., or 38.8 per cent., is for terminal charges. In the case of freight traffic the expenses are 4s. 11¾d. per train-mile, and of this the terminal charges absorb 3s. 2d., or 63.57 per cent., while of the 1s. 1d. expenses involved for each mile run by mineral trains 4¾d., or 37.13 per cent., are required for station terminals. Undoubtedly the percentages are lower in this country where the average haul for both freight and passengers is much greater, but we think it will be found upon investigation that there are large savings possible here by better and more enlightened practice in and about terminals.

In the operation of water-tube boilers a good automatic feed is a valuable aid in maintaining the proper water level. Mr. Yarrow, well-known in England for his work as a shipbuilder, and for the water-tube boiler he has invented and built for many government vessels, has in some recent boats adopted an automatic feed invented by Mr. Mariner, a manager in the Yarrow works. The system consists in feeding each boiler separately by a Worthington donkey pump, and placing the mouth of the steam pipe for supplying the donkey close to the water level of the boiler. If the water rises too high it will enter the donkey steam pipe and choke the cylinder with water. Then the donkey will almost stop. If the water level falls, then the donkey will work fast and pump the level up again. It has been found that when the water enters the steam cylinder the pump does not pound in an objectionable manner, as might perhaps be expected. The pump does not stop when the water enters the steam pipe, but runs slowly because the steam cylinder is larger than the water cylinder, the pump actually taking more water out of the boiler than it puts in. The heat in the water taken from the boiler is not lost, but is returned to it. It is said that in a recent three-hours' trial of a torpedo boat having this feed, the valves were not touched once.

The steamship *Germanic*, of the White Star Line, is to have a new set of engines built by Messrs. Harland & Wolff. The old engines were compound with two high-pressure and two low-pressure cylinders, arranged with the high-pressure cylinders on top of the low. These engines propelled the boat across the Atlantic 422 times, or a distance of over 1,000,000 miles. The progress in marine engineering during the last twenty years is well illustrated by a comparison of the old with the new engines. The old engines had two high-pressure cylinders, 48 by 60 inches, and two low-pressure cylinders 83 by 60 inches. The boiler pressure was 60 pounds, and at a speed of 50 revolutions they developed 5,700 indicated horse power. The boilers had 19,500 square feet of heating surface and 680 square feet of grate. The new engines are triple expansion, with cylinders 35¼, 58¼ and 96 inches in diameter and 69 inches stroke. The steam pressure has been increased to 170 pounds, and the new boilers have 18,169 square feet of heating surface and 558.6 square feet of grate. The new engines develop 6,500 horse power.

The construction of the Bergen Railway in Norway is now in full progress, and is attended with more engineering difficulties than have hitherto been met with in railway construction in that country. One of the most interesting features of the line is a tunnel 17,570 feet long. The snowfall in the country traversed by the line has been studied. It varies considerably; *Engineering* says that in some winters the depth averages three feet or four feet, while in others it is more than six feet. On the more exposed spots there is generally but little snow, while in hollows it may be 12 feet to 16 feet deep. The Voss-Tangevand section (about 46¼ miles) rises from a minimum of 180 feet to a maximum height above the level of the sea of 4,330 feet. This section will entail an expenditure of about £800,000, of which £150,000 will be required for the Gravelhalsen tunnel, the construction of which has been contracted for by a firm of Norwegian engineers. The works on the west side of this tunnel were commenced last autumn, and the rock has so far principally consisted of a hard slate. Operations are now about to begin at the other end of this tunnel, the completion of which is fixed for Oct. 1, 1903. At both ends water power is available for the working of boring machines, ventilators, &c. A large portion of that section lies above the forest boundary.

In a paper read before the American Society of Mechanical Engineers by J. M. Whitman, on the effect of retarders in the fire-tubes of steam boilers, the results of experiments are given and the following conclusions derived therefrom: 1. Retarders in fire-tubes of a boiler interpose a resistance varying with the rate of combustion. 2. Retarders result in reducing the temperature of the waste gases, and in increasing the effectiveness of the heating surface of the tubes. 3. Retarders show an economic advantage when the boiler is pushed, varying in the tests from 3 to 18 per cent. 4. Retarders should not be used when boilers are run very gently, and when the stack draft is small. 5. It is probable that retarders can be used with advantage in plants using a fan or steam blast under the fire, or a strong natural or induced chimney draft, when burning either anthracite or bituminous coals. 6. Retarders may often prove to be as economical as are economizers, and will not, in general, interpose as much resistance to the draft. 7. Retarders can be used only with fire-tubular boilers. 8. The economic results obtained on the boiler tested are ideal, showing that it was clean, the coal good in quality, and the firing skillful. With retarders the tubes are more effectively cleaned than without their use. 9. The tests prove that the marine practice of using retarders is good, and that the claim, often advanced, that they show from 5 to 10 per cent. advantage, holds, whenever the boiler plant is pushed and the draft is strong.

If the building of the battleship *Oregon* had been a co-operative enterprise in which nine-tenths of the men of the Pacific coast had personally participated, the satisfaction, not to say self-satisfaction, of the population could scarcely be more ingeniously displayed. The *Oregon* has revealed to the Pacific coast that it can build ships with the best, that the Union Iron Works of San Francisco can even beat the yards of the Cramps, for the new battleship's maximum of 17.34 and average of 16.79 take what is known in the world of battle as the belt. The workmen of the yards were only a little more demonstrative than the rest of the population when they tied ropes to the carriage of Irving M. Scott, the *Oregon's* builder, decked the same with flowers, and dragged him about, hundreds strong, as in a triumphal car. Mr. Scott made a speech to the men who had done the actual work on the battleship, recalled the Eastern taunt of a few years ago that the Union Iron Works constituted only a plant on paper, and, holding up some of the flowers, announced that he would save them for a bouquet to lay on the grave of the once-scornful Cramps. It has been proved that the Pacific coast can build war-ships; magnanimity and a sense of humor will come later.—*Harper's Weekly.*

The East Coast Route between London and Scotland has put some beautiful new trains in service recently. The cars have numerous features that are American. They have corridors the length of the cars, end doors, Gould vestibules, couplers and platforms, Westinghouse brakes, and car-heating apparatus of American manufacture. The cars are each 66 feet long. The construction of such cars is not without its significance. *Engineering* says in commenting upon the new trains: "After a very long life the British railway carriage with its independent compartments begins to show signs of having passed its meridian." It is to be noted, nevertheless, that this innovation is on a long distance train, and it is probable that if it finds favor at all it will be confined to long distance travel. Mr. Worsdell, Locomotive Superintendent of the North-Eastern Railway, has designed and constructed five express engines for these East Coast trains. The cylinders are 20 inches in diameter, and have a stroke of 26 inches. There are four coupled wheels 7 feet 7¼ inches in diameter, and there is a four-wheel bogie. The boiler is 4 feet 4 inches in diameter and over 11 feet in length. The firebox is 7 feet long, and the center of the boiler from the rails is over 8 feet. The boilers are constructed to carry a pressure of 200 pounds per square inch. In addition to the five engines already completed, 10 others are under construction, and a large number of tenders are being fitted up with the water scoop. It is evident, therefore, that the East Coast Route is ready to compete for the traffic to Scotland,

either by excellence of accommodation or by a good showing in another "race to the north."

In the evening of August 8, a peculiar accident happened at the Brooklyn Navy Yard. The caisson or gate of dry dock No. 2 gave way and as the dock was empty at the time the inrush of water tore a number of vessels from their moorings. A pile driver, a lumber lighter and the torpedo boat *Ericsson* were carried into the dock and the latter's bow was badly damaged. The steam launch of Commodore Sicard was wrecked and sunk inside of the dock. The war vessels *Atlanta*, *Katadin*, *Terror* and *Puritan* were carried into the channel and toward the dock by the current, but were caught and towed back to their moorings before any damage was done them. The dock and the gate were both damaged and the total bill for repairs is variously estimated to be from $100,000 to $250,000. The gate is of steel and was ballasted with rock which had nearly all been removed preparatory to putting a ballast of concrete, and to its lightened condition is attributed the accident.

An interesting method of testing lubricants when a regular oil tester is not at hand, but where electrical apparatus is available, was recently described by Mr. P. MacGahan, in the *Electrical World*. It consists of employing a shaft driven by a small shunt wound electric motor and fitting it with two bronze or babbitt metal boxes, so arranged that a known weight can be applied to them and the lubricant properly introduced. The speed of the motor can be regulated within one per cent. by means of a water barrel in the armature circuit and rheostat in the field circuit. The power supplied to the motor is observed by means of a watt-meter. The watts required when there is no pressure on the bearing is deducted from the readings obtained when the pressure is put on. From the watts used the speed of the rubbing surfaces and the pressure, the co-efficient of friction can be accurately determined. The equation

$$F = \frac{W \times 44.2}{S}$$

gives the friction in pounds, W being the watts consumed, S the speed of the rubbing surfaces in feet per minute, 44·2 the foot-pounds per watt expended, and F the friction in pounds; whence we obtain

$$K = \frac{F}{P} = \frac{W \times 44.2}{PS}$$

where K is the co-efficient and P the total pressure on the bearing.

In an article in the *Iron Age*, Mr. P. Kreuzpointer made the following comparison between test pieces of various lengths and areas. A few results of tests given below will illustrate better than any words the remarkable difference between the extremes of modern test section, where the 8-inch section comes nearest the natural conditions of the full-sized plate or structural member, while the 1-inch or groove section is further from it, hence giving fictitious values. While a test section where elongation is measured in 10 or 12 inches would still be nearer to the ideal, the difference between these and an 8-inch length is so small that it can be omitted in practice, saving thereby a good deal of metal and cost of preparation:

Elongation with Geometrically Dissimilar Test Pieces.

Per Cent.

2½ by ½ inches.	1½ by ½ inches.	½ by ½ inches.	In inches.
67	61	55	1
50	43	40	2
36	31	30	4
30	26	26	6
27	24	23	8

Tensile Strength.

Test Section, 1½ inches by ½ inch.

Length of section in inches	1	2	4	6	8
Pounds per square inch	72,000	65,1[illegible]0	62,700	60,300	59,000

In the last report of the Australian Railway Commissioners particulars were given of a new locomotive, which had been designed under their directions especially to meet the requirements of the New South Wales lines. It is aptly named the "Australian Consolidation" engine and considerable interest has been attracted by the appearance of the first of the engines in steam. The trial runs, it is understood, were most satisfactory, indicating that the new locomotive fully meets all that was desired when it was designed. The New South Wales *Railway Budget* says that the engines, five in number, have recently arrived and have been put together at Eveleigh. They are big engines, necessarily so, to perform the work set them, and have been built by Messrs. Beyer, Peacock & Company, Limited, detail drawings, specifications, etc., having been prepared by the Chief Mechanical Engineer in Australia. The engines are designed in accordance with the English practice permitting of plate frames, copper fireboxes and brass tubes being used. The journals and crank pins are encased in dust proof shields, a very desirable protection in dry climates, such as are met with on many of the New South Wales main lines. These engines have outside cylinders 21 inches diameter by 26-inch stroke, with eight coupled wheels, and a two-wheeled radial truck; the Westinghouse automatic brake is applied to all the coupled wheels. The valve motion is of the Allan straight-link type, with balanced slide valves, and trick ports. The boiler and fire box are constructed on the Belpaire principle, working at a steam pressure of 160 pounds per square inch, and containing a total heating surface of 2,211 square feet, with a grate area of 29.75 square feet. The tenders are of the double bogie type, capable of carrying 3,650 gallons of water and six tons of coal, and are equipped with the Westinghouse automatic brake.

	Ft.	In.
Diameter of coupled wheels	4	3
Coupled wheel-base	15	0
Total wheel base of engine	23	2
Total wheel-base of tender	16	0
Total wheel-base of engine and tender	51	10¼
Total length over buffers	60	3¾
Centers of cylinders transversely	7	0
Width over cylinders outside	9	2¾
Height of center of boiler above rails	7	8

The haulage power (exclusive of engine and tender) that it was estimated the engine could manage on a 2½ per cent. grade was 350 tons, at a speed of 10 miles per hour, and it is said that on the trial runs this has been satisfactorily covered.

The Prussian State railways are experimenting with a new composition of oils and fats for lubricating car axles. The following test was made with the new lubricant on Corridor Car No. 562, running between Berlin and Frankfort-on-Main: The new lubricant was applied in all the eight axle boxes. The method of application was to impregnate 16 cushions, made of a cheap shoddy material, with the new lubricant, and placing these, the one under and the other over the axles in each box. The remaining space was filled up with the composition. The total weight of lubricant thus applied was 16 kilogrammes. The car was run in the regular passenger train service, and after running 5,000 kilometers a slight addition of the lubricant was made in each axle box. At the end of a run of 30,000 kilometers the car was held over at the Berlin station and a careful inspection made. The cushions were removed and weighed, and likewise the composition in the axle boxes carefully taken out and weighed. The cushions and grease were replaced in the boxes with some addition of fresh material, an exact record of weight being kept. This was repeated as each 30,000 kilometers of train services were run by the car. The saving, according to the official figures, comes out at 15.84 marks per 30,000 kilometers of train service, or about one-half of present cost per car. The severest cold weather of Northern Europe does not have any effect on the composition, as its freezing point is 28 degrees Centigrade. On the other hand, the warmest weather does not cause the composition to run. The results of the tests may be summed up approximately as follows: One application of lubricant suffices for 3,100 miles of train service, and in running 55,800 miles the consumption is about 69 pounds, which is about 1¼ grains per 100 miles run for each axle box. The Prussian Government pays about 15c. per pound for the composition.

Personals.

Mr. William W. Borst has been appointed Receiver of the Denver, Lakewood & Golden Railroad.

Mr. E. P. Ripley has been elected President of the Sonora Railway and New Mexico & Arizona Railroad.

Mr. H. Fegraus, of Duluth, Minn., has been appointed Chief Engineer of the Duluth & North Dakota.

Mr. J. P. Lyman, General Manager, has also been elected President of the Chicago, Hammond & Western.

Mr. N. Monsarrat has been elected Vice-President of the Columbus, Hocking Valley & Toledo Railway.

C. Millard has been appointed Chief Engineer of the St. Louis, Chicago & St. Paul, with office at Springfield, Ill.

Mr. J. T. Walch has been appointed Master Mechanic and Master Car Builder of the Oregon Central & Eastern.

Mr. Joseph McWilliams is now General Manager of the Marietta & North Georgia, with headquarters at Marietta, Ga.

Mr. Edward Woodbury, of Kalamazoo, has been elected President of the Chicago, Kalamazoo & Saginaw Railway.

Mr. Wm. Rutherford, Superintendent of Motive Power and Equipment of the Plant System of Railways, has resigned.

Mr. John Oliver, formerly for 15 years Purchasing Agent of the Baltimore & Ohio, died at Baltimore, Md., July 15, after a long illness.

Mr. R. B. Levy, Sr., has been appointed Receiver of the Texas, Sabine Valley & Northwestern, to succeed Mr. Leon H. Hart, resigned.

Mr. J. L. Polk has been appointed Acting General Manager of the Gulf, Colorado & Santa Fe, to succeed Mr. B. F Yoakum, resigned.

Mr. Jonathan Evans has been appointed Master Mechanic of the Washington & Columbia River Railway, vice William Saxton, resigned.

Mr. D. W. McLean, Master Car Builder of the Kansas City Fort Scott & Memphis at Fort Scott, Kan., died at Grand Rapids, Mich., July 27.

Mr. Thomas Inglis, Master Mechanic of the St. Louis Southwestern, at Tyler, Tex., died recently. He is succeeded by Mr. J. M. Scrogin.

Mr. William S. McGowan, Jr., has been elected Treasurer of the Hancock Inspirator Company, of Boston, vice Mr. Edward P. Noyes, resigned.

Mr. William Whyte, Superintendent of the Texas Trunk, has been appointed Receiver of that road to succeed Mr. George T. Atkins. His office is at Dallas, Tex.

Mr. Edwin McNeil, Receiver and General Manager of the Oregon Railway & Navigation Company, has been chosen President of the reorganized company.

Mr. J. M. Schoonmaker has been elected President of the Pittsburgh, Chartiers & Youghiogheny Railway to fill the unexpired term of J. H. Reed, resigned.

Mr. D. C. Courtney has been appointed Division Master Mechanic of the Baltimore & Ohio Railroad, at Grafton, W. Va., in place of Mr. S. A. Souther, resigned.

Mr. S. B. Wight, Secretary to President Ledyard, of the Michigan Central, has been appointed Assistant Purchasing Agent of that road, with office at Detroit, Mich.

Mr. W. A. Walden, of Charlotte, N. C., has been appointed Master Mechanic of the Southern Railway at Burlington, N. C., to succeed Mr. T. S. Inge, transferred to Columbia, S. C.

Mr. E. T. Smith has resigned as Purchasing Agent of the St. Louis & San Francisco, and the office is abolished. General Manager Yoakum will hereafter look after the purchase of supplies.

Mr. S. R. Tuggle, Superintendent of Motive Power and Machinery of the Houston & Texas Central, has also been made Superintendent of Motive Power and Machinery of the Galveston, La Porte & Houston.

Mr. Charles Warren, General Manager of the Great Northern, has retired. Mr. James M. Barr, General Superintendent, has been assigned certain duties heretofore performed by the General Manager, and the latter office will be abolished.

Mr. W. E. Guerin has been elected President of the Columbus, Sandusky & Hocking Railroad, to fill the vacancy caused by the resignation of N. Monsarrat. Mr. Charles Parrott has been elected Vice-President, to fill the vacancy caused by the election of Mr. Guerin.

Mr. Edward S. Washburn, Vice-President of the Kansas City, Fort Scott & Memphis, has been chosen President of that road and the Kansas City, Memphis & Birmingham. It is announced that he will also assume the duties of General Manager of the roads named and associated lines.

Mr. Joseph A. Jordan, General Manager of the St. Louis & Hannibal, has been elected Vice-President of the Green Bay & Western, which has but recently been reorganized, to succeed the Green Bay, Winona & St. Paul. Mr. Jordan will continue as General Manager of the St. Louis & Hannibal.

Mr. F. P. Olcott has been elected President and Mr. J. H. Hill General Manager of the Galveston, Houston & Henderson road in Texas. Mr. Hill was appointed to this office some months ago, but has not yet been placed in active charge of the operation of the line, which still continues under the direction of the Operating Department of the International & Great Northern.

Mr. A. L. Studer, Master Mechanic of the West Iowa Division of the Chicago, Rock Island & Pacific, at Stuart, Iowa, has been appointed Master Mechanic of the Southwestern Division, in charge of the Locomotive and Car Department, with headquarters at Trenton, Mo., to succeed Mr. William Gessler, resigned. Mr. J. B. Kilpatrick is given jurisdiction over the West Iowa Division in addition to his other duties.

Mr. Frederick Harrison, General Manager, and Mr. Robert Turnbull, General Superintendent, of the London & North Western Railway, of England, arrived in New York by the Cunard line steamer *Lucania* on Saturday, Aug. 22. These gentlemen are coming over on a tour of recreation and observation, and after two days' stay in New York, will proceed to the Pacific Coast, visiting all places of interest *en route* in the States and Canada, returning to New York in October. They will be entertained by a large number of American railroad officials, and every facilitation will be afforded them to inquire into the American system of railroads, etc.

Mr. Robert Garrett, formerly President of the Baltimore & Ohio road, and the son of Mr. John W. Garrett, who did so much in the building up of the road, died on July 29. Mr. Garrett was born at Baltimore in 1847, and was graduated from Princeton University in 1867. After a short training in the banking house of his father he entered the railroad field, being made President of the Valley road of Virginia in 1871, Third Vice-President of the Baltimore & Ohio in 1879, First Vice-President in 1881, and President in 1884 on the death of his father. In October, 1887, he resigned the Presidency, and Mr. Samuel Spencer became President. During Mr. Garrett's administration the Philadelphia division of the road was built, and the B. & O. express and telegraph lines were built up only to be sold out at a great loss.

Equipment Notes.

Five locomotives are under construction at the Brooks Works for the Chicago, Rock Island & Pacific Railway.

The Michigan Central is building three new locomotives, two switch and one passenger, at its St. Thomas shops.

It is stated that the Lake Shore & Michigan Southern will order soon 12 or more locomotives and about 900 freight cars.

The Chicago, Rock Island & Pacific Railway has ordered 100 coal cars to be built by the Michigan Peninsular Car Company.

A contract for building ten Page dump cars has been let to the United States Car Company, and will be built at Hegewich.

The Great Northern has placed an order with the Brooks Locomotive Works for 12 mogul engines with 19 by 26-inch cylinders.

It is reported that the Chicago & Northwestern contemplates adding about 5,000 new freight cars to its equipment during the year.

The Indiana Pipe Line and Refining Company has placed an order of fifty 8,000 gallon tank petroleum cars with the Terre Haute Car Works.

The Illinois Central has contracted for the construction of six ten-wheeled and eight eight-wheeled passenger locomotives, five moguls and four six-wheeled switchers. This order is divided between the Brooks and Rogers Locomotive Works.

The Pittsburgh Locomotive Works recently delivered to the Seaboard Air Line twelve ten-wheel engines with cylinders 19 by 24 inches. They have also shipped lately two six-wheel connected side tank engines with cylinders 13 by 20 inches for the Ota Railway of Japan.

The records of the Georgia courts show that the cars recently ordered by the Georgia Railroad from the Ohio Falls Car Manufacturing Company are to cost as follows: Two hundred ventilated box cars, $434 a car; 65 drop-bottom gondolas, $340 a car; 50 platform cars, $286 each, and 10 stock cars, $414 each.

In stating in our July issue that the Richmond Locomotive Works had not received an unqualified order for alterfng over 60 Big Four engines to the compound system, we were in error. The order has been given for the entire 60 engines, but, of course, the work of alteration will be carried out only as the engines come in the shop for general repairs.

H. K. Porter & Company, of Pittsburgh, some time ago secured a contract for equipping the Eckington and Soldiers' Home Street Railway of Washington with traction cars and compressed air motors. The new cars will resemble ordinary cable cars and will be about 20 feet long. The power will be placed beneath the seats and the floor of the car. The air will be stored in eight iron retorts nine inches in diameter and as long as the car. The air will be stored at a pressure of 2,000 pounds to the cubic nch. The air pressure in the storage tanks is reduced before used in the motor and is to be heated by passing it through hot water. The power is regulated by ordinary levers, and the system is almost identical with a steam or compressed air locomotive.

Report of the Committee on Fire-Proofing Tests.

The following report, addressed to the Tariff Association of New York, the Architectural League of New York and the American Society of Mechanical Engineers is of unusual interest. The joint committee appointed to investigate and test fire proofing for structural metal in buildings and to obtain data for standard specifications, is as follows: S. Albert Reed for the Tariff Association, Geo. L. Heins for the Architectural League and H. de B. Parsons and Thomas F. Rowland, Jr., for the American Society of Mechanical Engineers. The committee, after having effected its own organization, determined to add to its numbers by the creation of an Advisory Board. This step was taken for the purpose of more widely increasing the interest taken in the experiments, and also to prevent, as far as possible, the impression that the work was of a sectional or local character. The names of the gentlemen who accepted invitations to serve on this Advisory Board are as follows:

Edward Atkinson, President Boston Manufacturers' Mutual Fire Insurance Company.
Osborne Howes, Secretary Boston Board of Fire Underwriters.
Charles A. Hexamer, Secretary Philadelphia Fire Underwriters' Association.
W. Martin Aiken, Supervising Architect, United States Treasury Department, representative Illinois Chapter, American Institute of Architects.
George B. Post, New York Chapter, American Institute of Architects.
Stevenson Constable, Superintendent of Buildings, New York.
F. H. Kindl, Structural Engineer, Carnegie Steel Company.
John R. Freeman, Chief Instruction Department, F. M. I. Companies.
Henry Morton, President Stevens Institute of Technology.
C. H. J. Woodbury, member American Society of Civil Engineers.
H. B. Dwight, Dwight Survey and Protection Bureau, New York.
F. C. Moore, delegate New York Board of Underwriters to Board of Examination of Department of Buildings.
Wm. A. Wahl, Secretary Franklin Institute, Philadelphia.
John T. Williams.

The committee publicly thanks the parties mentioned below for their offers of assistance, namely: The Continental Iron Works, for permission to use part of their yard and for numerous courtesies which have been extended to the committee from time to time; the Carnegie Steel Company, Limited, for their offer to furnish all the structural steel that the committee may need; J. B. & J. M. Cornell, for their offer to furnish the cast iron columns for which the committee may ask; Sinclair & Babsen, for their donation of 75 barrels of Alsen cement; the Lorillard Brick Works Company, through Henry M. Keasbey, for 54,000 common bricks; Henry A. Maurer, for his donation of 14,000 fire bricks and 14 barrels of fire clay.

The report says:

During the winter just past your committee erected a testing plant, as shown in the accompanying photograph, Fig. 1. The gas producer in the background is 9 feet in diameter by 12 feet in

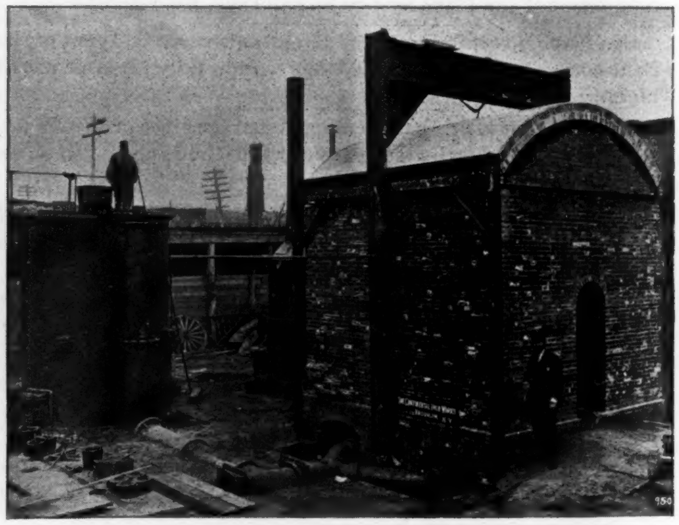


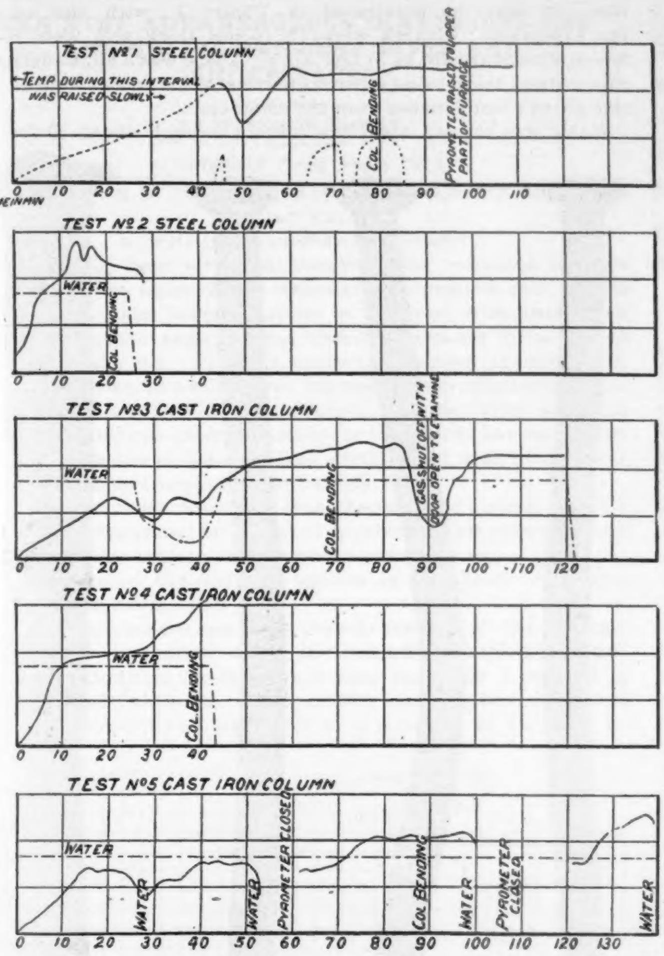
Fig. 1.—View of Testing Plant.

height, and is equipped with a hopper valve on top. Gas is generated by means of steam from the boiler, as shown, and carried into the furnaces through pipes, as clearly indicated in the photograph. The foundation shown on the left is ready for the erection upon it of a furnace for testing beams and floors. Its dimensions are: length, 27 feet; width, 12 feet; but it can be arranged to take larger beams if so desired. The furnace shown on the right is for testing columns, and is 14 feet square, outside measurement.

The arched roof is made of fire brick and is independent of the side walls, being supported by outside corner posts. The walls are of common brick, but can easily be changed so that experiments can be made on other materials. One side wall and the end wall with the door are 12½ inches in thickness; the rear wall is 8½ inches, and the fourth wall is 4 inches inside, 2 inches air space and 8½ inches outside, making a total thickness of 14½ inches.

The floor is covered with fire brick, with openings left for the branch gas pipes and air spaces to support the combustion. These branch gas pipes are 4 inches in diameter, capped with tuyeres reduced to 2 inches. In order to increase the temperature when desired, a barrel of naphtha is connected by means of a small pipe and blown into the gas pipe at the Y-branch by means of a steam jet.

The column is placed in compression by means of a hydraulic ram underneath, resting on three 24-inch I-beams the same as those across the top of the furnace shown in photograph. In order to keep the entire length of the column within the furnace filler blocks of cast-iron are placed between the ends of the column and these I-beams. The hydraulic ram is 12 inches in diameter and the water



Full lines show temperature—each vertical space equalling 500° F.
Broken lines show load—each vertical space equalling 50 tons.

Fig. 2.—Diagram of Tests.

pressure can be carried to 2,500 pounds per square inch. The temperature is measured by means of a Uehling & Steinbart pyrometer

The money to carry out this work has been advanced by various parties. The money expended up to July 22, 1896, is $3,103.30.

Your committee decided that it would be best to make the tests according to the following programme:

First.—That a series of tests be made on steel and on cast-iron columns, without any fire protection whatever. These tests then to be taken as a basis of comparison with those that were to follow.

Second.—That a series of tests be made with similar steel and cast-iron columns, protected with different materials and in different manner.

Third.—That a series of tests be made on unprotected beams and girders.

Fourth.—That a series of tests be made on protected beams and girders.

It has also been proposed that each series be be divided for test both with and without water.

Your committee has communicated with many manufacturers of fireproofing materials, and has been informed that these manufacturers will submit their materials for purposes of tests.

RESULTS.

The result of this series of tests is shown in the accompanying diagram, Fig. 2, where the solid line represents the temperature and the dotted line the load on the column.

Test No. 1 was made on a steel column, when the temperature was rapidly raised. Test No. 3 was made on a cast-iron column under similar conditions. Both columns began to fail as soon as they showed "red."

Test No. 2 was made on a steel column, when the temperature was raised more slowly than in the other tests just described, and test No. 4 was made on a cast-iron column under similar conditions. Both these columns failed when they began to show "red," although the time was longer than in Tests 1 and 3.

Test No. 5 was made on a cast-iron column, a jet of water being thrown upon it through a ¾-inch nozzle. The column was first heated to 675 degrees and then quenched with water without injury. The heat was then slowly raised again to 775 degrees and the column again quenched with water. The heat was then raised slowly to a temperature of 1,075 degrees and the column, which then showed a "dull redness," was again quenched with water. The heat was then raised again to 1,300 degrees and the column, which now showed a "bright red," was again quenched with water. The column was beginning to yield by bending just before the last application of the water. The column was apparently unaffected by water, although it failed by bending under the load the same as in Cases 3 and 4.

Column Test No. 1, May 19, 1896.—Fire test without water; steel column.—The walls of the furnace were of common brick, as described, and the door was closed with a double thickness of sheet iron, which made the opening practically tight. The column was a Carnegie steel box channel, of the dimensions as shown in Fig. 2, and was unprotected. The weather was clear and warm, with only a slight breeze from the west. The temperature of air 80 degrees Fahr., in the shade. The gas producer was fired the day before, with valve closed against the furnace. The packing in the hydraulic cylinder leaked and a fitting of the pipe gave out as test started. These causes delayed the use of the water pressure.

LOG.

Time. H M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
10.35	....	....	Wood fire lit.
10.45	....	....	Gas turned into furnace.
11.13	....	....	Pyrometer put in furnace through lower hole, 2½ feet above the furnace floor, with point 12 inches from column.
11.20	1,050	....	Pressure on column. Light load. Pyrometer point 24 inches from column.
11.36	1,225	....	Half faucet of naphtha.
11.40	1,175	14.13	Water pressure on.
11.41	1,1[illegible]0	28 26	Quarter faucet of naphtha.
11.46	1,175	..	Pressure off, water valve repacked.
11.50	1,175	....	Closed all air openings. Water pressure on.
11.55	1,200	48.06	Column began to show "red."
11.56	1,210		Column began to yield.
1[illegible].59	1,225	42.41	Hydraulic pressure failing fast.
12.25	1,250	....	Gas shut off.

The column would have failed sooner if the working load of eighty tons could have been used. After the column was removed

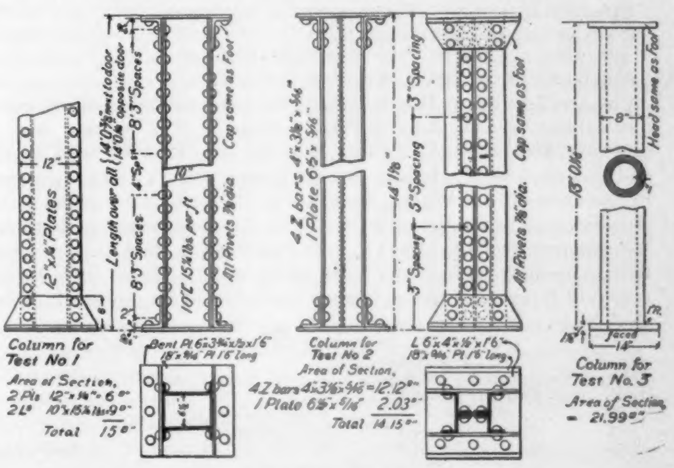


Fig. 3.—Columns for Tests 1, 2 and 3.

from the furnace a photograph, Fig. 4, was taken. The brick walls cracked, the greatest damage taking place where one wall was bonded into the next and the cracks at these places extended through the bricks. Along the horizontal joints the walls cracked most on the bond courses. All the walls were hot, the eight-inch wall being too hot to hold the hand in contact with it.

STRENGTH OF GORDON'S FORMULA.

Breaking strength per square inch, 45,630 pounds.
Area of cross-section 15 square inches.
Breaking load, 15 by 45,630, 684,450 pounds, 342 tons.
Actual greatest load, cold, 141.4 tons, with no change of form.

Column Test No. 2, May 27, 1896.—Fire test without water; steel column; furnace same as Test No. 1.—The column was a Carnegie steel Z bar, as shown in Fig. 3, and was uncovered. The weather was clear and warm, with a moderate breeze from the northwest. Temperature of air, 80 degrees Fahr. in shade.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.23	80	....	Pyrometer point 3 feet from column.
2.24	200	84.8	Wood fire lit.
2.30	650	84.8	Gas turned on.
2.35	1,000	84.8	One-quarter cock of naphtha.
2.38	1,375	84.8	Naphtha closed.
2.40	1,125	84.8	One eighth cock of naphtha.
2.44	1,175	84.8	Naphtha cock closed to "dropping."
2.45	....	84.8	Pyrometer moved to 2 feet from column as flame touched point.
2.46	1,125	84.8	Column began to yield.
2.47	1,124	84.8	Column yielding fast.
2.49	1,100	84.8	Impossible to maintain hydraulic pressu e.
2.51	1,100	84.8	Pump and gas stopped.
2.52	900	84 8	Pyrometer closed.

STRENGTH OF GORDON'S FORMULA.

Breaking strength per square inch, 42,820 pounds.
Area of cross-section, 14.15 square inches.
Breaking load, 14.15 by 42,820, 605,900 pounds, 303 tons.

Column Test No. 3, June 30, 1896.—Fire test without water; cast-iron column; furnace same as Tests 1 and 2.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, as shown in Fig. 3, and was uncovered. It was cast horizontally, with a dry sand core, by the Cornell Iron Works, New York. The weather was clear and warm, with a slight breeze from the southwest. Temperature of air, 75 degrees Fahr.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.32	....	14.1	Wood fire lit.
2.45	....	84.8	Gas lit, door being closed.
2.50	....	84.8	Pyrometer in place, 18 inches from column.
2.51	575	84.8	
2.57	625	84.8	Gas shut off to poke producer.
3.00	475	56.5	Removed some loose bricks that interfered with tuyeres.
3.05	450	28.2	Gas turned on, door closed.
3.06	650	15.5	
3.08	667	....	Air openings closed.
3.12	600	11.3	Door down to arrange bricks.
3.13	650	....	Door closed.
3.13½	750	....	Naphtha valve opened one-half.
3.37	1,125	84.8	Slight redness reported by some.
3 40	1,137	84 8	Column bent slightly.
3.55	1,200	84.8	Gas shut off, door down, column decidedly red and bent.
4.04	387	84 8	Gas on and door closed.
4.08	925	84.8	No naphtha.
4.09	925	84.8	Naphtha turned on one-half cock.
4.32	1,125	84.8	Gas shut off, stopped pumping.

Strength by Gordon's formula was as follows:

Breaking strength, 902,000 pounds.
Safe load $^1/_5$ by 902,000, 180,400 pounds, 90.2 tons.

The result of test No. 3, is shown in Fig. 5.

Column Test No. 4, July 6, 1896.—Fire test without water; cast-iron column furnace same as Tests 1, 2 and 3.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core by the Cornell Iron Works, New York. The column was the same as illustrated in the cut (Fig. 3), with the following exceptions: Length over over all, 13 feet ⅜ inch thickness of flanges, 1⅝ inches flanges re-enforced by four ribs each seven-eighths inch thick, reaching from outer end of flange to cylinder at an angle of about 45 degrees.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.22	....	....	Wood fire fire lighted.
2.25	....	84.8	Gas lighted.
2.28	....	84.8	Pyrometer placed 18 inches from column.
2.29	....	84.8	Door closed.
2.30	675	84 8	
2.49	1,000	84.8	Naphtha used, one-quarter cock.
2.51	1,100	84.8	
2.52	1,125	84.8	More naphtha, three-eighths cock.
2.53	1,200	84 8	More gas.
2.54	1,300	96 1	
2.57	1,350	84.8	Column bending.
2.59	1,350	84.8	More naphtha, half cock.
3.01	1,375	84.8	Color reported.
3.03½	1,525	84.8	Column yielding fast.
3.05	1,550	84.8	Column broke suddenly.

The fracture occurred at the center of the column, Fig. 6, where the deflection was the greatest. There was a crack about 5 inches long about 7 inches above the fracture on the convex side of the column, showing that the column first pulled apart on the outside of the bend. No water was thrown on this column during the test.

Column Test No. 5, July 10, 1896.—Fire Test with Water. Cast-Iron Column. Furnace same as Tests Nos. 1, 2, 3 and 4.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core, by the Cornell Iron Works, New York. The column was the same as illustrated in Figure 7, with the following exceptions: Flanges were 1⅝ inches thick, and were re-enforced with four ribs, as in test No. 4. There was a slight defect in this casting, there being a porous portion a few inches long on one side about 3 feet 6 inches from the lower end.

Water was thrown upon the column through about 50 feet of

Fig. 5.

Fig. 6.

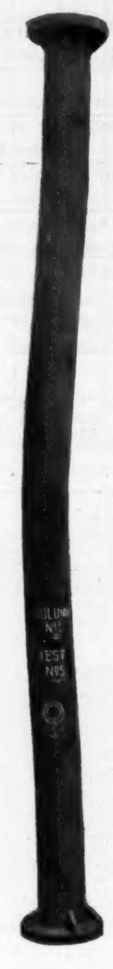


Fig. 7.

Fig. 4.

2½-inch rubber hose and a three-quarter-inch nozzle. The pressure at the hydrant was 50 pounds.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.16	....	84.8	Wood fire lighted.
2.28	....	84.8	Gas lighted.
2.29	600	84.8	Door closed. Pyrometer in place 18 inches from column.
2.36	675	84 8	Pyrometer moved back 5 feet from column.
2.42	525	84.8	Water thrown on column one minute.
2.43	450	84.8	Door open. Fire out.
2.44	400	84.8	Door open. Fire relighted.
2.46	425	84.8	Door closed.
2.58	750	84.8	Pyrometer 3 feet from column.
3.02	750	84.8	Pyrometer 18 inches from column.
3.05	785	84.8	Pyrometer 5 feet from column.
3.09	400	84.8	Water on column half minute. Fire out. Door down.
3.16	....	....	Gas relighted. Door closed.
3.19	685	84.8	Pyrometer 18 inches from column.
3.22	700	84.8	More air admitted.
3.35	1,025	84.8	
3.50	1,050	84.8	Column red.
3.55	1,075	84.8	Water on column half minute. Fire out. Door down. More water on column as it was still red.
4 13	....	84.8	Gas relighted.
4 17	750	84.8	Pyrometer 18 inches from column.
4.21	787	84.8	Naphtha, half cock.
4.30	1,250	84.8	Column getting red.
4.31	1,275	84.8	Column bending.
4.34	1,300	84.8	Pyrometer moved back. Water on column one minute.
4.35	....	84.8	Door down and water on column again two minutes.

The result of the test is shown in Fig. 7.

The column was very red when the water was thrown on it the last time. The brick walls and arch roof cracked when water fell on them. The column was badly bent, but otherwise appeared uninjured.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(*Continued f om Page* 192.)

VI.—INFLUENCE OF THE INCLINATION OF THE STACK UPON THE VACUUM.

a. With the Same Bottom Diameter.

It has already been seen and discussed with reference to Plate II., in which the waist-shaped stacks are represented, that, within certain limits, the lowest vacuum is obtained with that stack which, having the same bottom opening, flares out to the largest diameter at the top. Plate VI. under *C* illustrates the same fact, and it is shown in a still more convincing way relatively to the funnel-shaped stacks under *B* in Plate V. In the latter plate the lines of the diagram placed together for two stacks having a diameter of 13.78 inches at their smallest section and with inclinations of one-twelfth and one-sixth respectively.

We see from these diagrams that the full lergth stack with the straightest sides produces 60 per cent greater vacuum than the stack having the same bottom diameter but a greater flare.

Zeuner reached the opposite opinion in his theory of conical stacks as stated in Section I.

Fig. 55 shows, on a larger scale, the relationship of the two conical stacks to each other when the nozzle diameter is 4.74 inches. The nozzle distances (abscissas) are here shown in a scale of $\frac{1}{15}$ their full size, while the corresponding vacuum (the ordinates) is shown on a scale of half size. But it is possible, as we have al-

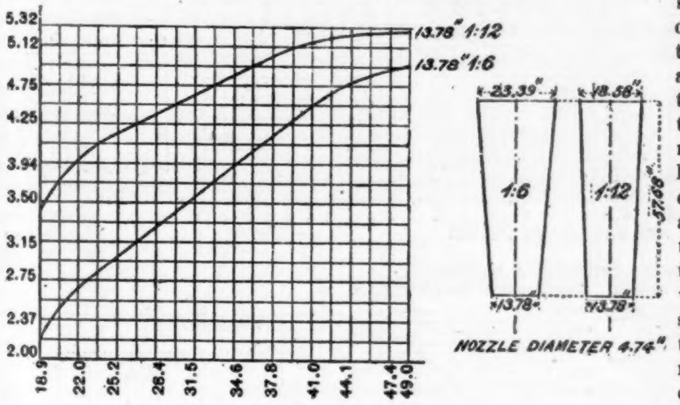


Fig. 55.

ready demonstrated, to obtain the same action with both stacks by using a greater nozzle distance with that stack which has the greater flare. According to Plate V. this must average about 12.60 inches greater in the stack with $\frac{1}{6}$ inclination than in the one having $\frac{1}{12}$.

The lines of the diagrams under *A* in Plate VI. show the same thing for stacks that have been shortened 19.68 inches at the top.

b. With the Same Top Diameter.

In Plate V., under *C*, two groups of stacks of three each are shown; they have the same top diameter but different flares or inclinations. In one group the corresponding diameters are about 2 inches larger than in the other. Both groups exhibit the same contour of lines, which shows that:

With the same top diameter, that stack creates the greatest draft which has the smallest bottom diameter and which is contracted the most toward the bottom.

The lines of the diagram under *B* in Plate VI. show the same thing. Here two stacks are compared that have been shortened 19.68 inches at the top and which have a flare of $\frac{1}{6}$ and $\frac{1}{12}$ respectively as before. In consequence of the large amount that has been cut off from the top and the slight differences in the diameters resulting therefrom, the vacuums belonging to the two stacks do not differ so much from each other as they do in the case of the longer stacks represented in Plate V.; but the more sharply contracted stack always produces a draft about 19 per cent. greater.

In Fig. 56 we have given, on a larger scale the diagrammatic lines of two full-length stacks of the same top section, but with waists of different diameters, the nozzle diameter for both being 4.74 inches. The vacuums are represented by the ordinates and the

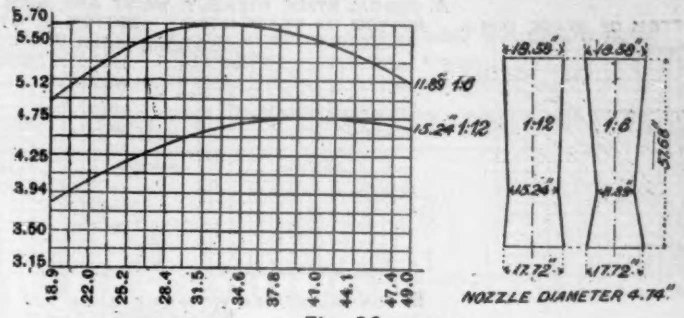


Fig. 56.

corresponding nozzle distances by abscissas. We see from the diagram, that the vacuum here increases about 1.18 inches, or 28 per cent., if the stack having a waist diameter of 15.24 inches is changed for one having a diameter of 11.89 inches, the diameter at the top remaining unchanged. These facts, taken in connection with that graphically shown in Fig. 55 for stacks having the same bottom diameter, form the basis for the statement made in section X., that in the theories of locomotive exhaust nozzles and stacks the equalization for the conicity of the stacks must be made in another way, as is done.

The curves under *C* of Plate V. are not instructive when read in any other way. At the right the waist-shaped stac s have the sides shown prolonged in the dotted lines to the bottom, and the smallest diameter, which would then be formed, marked.

By making a comparison of the curves we can readily determine the influence of the foot of the stack, as discussed in the preceding section. For short nozzle distances, in which the current of steam does not present a sufficiently large surface for drawing in the air, the funnel-shaped stack with a flare of ⅙ (especially where the diameter is small) has a weaker effect than the waist-shaped stack with the same flare; but when the nozzle distance drops to about 0.4 of the total height of the stack, the two are about equal in effectiveness, while for greater distances the funnel-shaped stack no longer appears to be superior to the waist-shaped. For all the abscissas of Plate V. both stacks have the same total heights, and agree perfectly in having their upper sections 40.02 inches long, but the difference lies in the fact that, with the funnel-shaped stacks the nozzle is always about 17.52 inches nearer the smallest section, which has a diameter of 15.75 inches than is the case of the waist-shaped stacks, with a waist 17.2 inches in diameter. Now, according to Section VIII. we find that a confined jet of steam in the experimental apparatus had a flare of about 1 in 2.4; so that at a distance of 29.92 inches (760 millimeters) from the nozzle it would have an approximate diameter of $\frac{29.92}{2.4}$ + the diameter of the nozzle, that is with a nozzle 4.74 inches in diameter it would be

$$12.46 + 4.74 = 17.2 \text{ inches.}$$

Thus at about 29.92 inches from the nozzle opening the current of steam begins to fill the section having a diameter of 17.2 inches, so that there is no free outlet for the mantle of air that is drawn in with and surrounds the inclosed portion of the steam jet. With the nozzle opening located at a still greater distance, the passage of the steam and air will be checked still more, the consequence of which will be that there will be a still greater loss of vacuum by impingement against the side of the funnel-shaped foot and the contraction to which the current will be subjected.

The case of the funnel-shaped stack is somewhat different. Here instead of a nozzle distance of 29.92 inches from the waist in the preceding stack we have a nozzle distance of only $29.92 - 17.52 = 12.4$ inches from the smallest cross-section, so that the steam jet has a free entrance into the barrel of the stack, and the entrained air is carried through it unchecked by friction against the sides. It will be at a distance of about $x = (15.75 - 4.74) \times 2.4 = 26.42$ inches that the current of steam would begin to fill the smallest section, as shown in Fig. 57, which corresponds in Plate V. to the abscissa of $26.42 \times 17.52 = 43.94$ inches. We see, as a matter of fact, that at about 3 feet 7⅛ inches measured on the line of the abscissas the line in the diagram curves sharply down

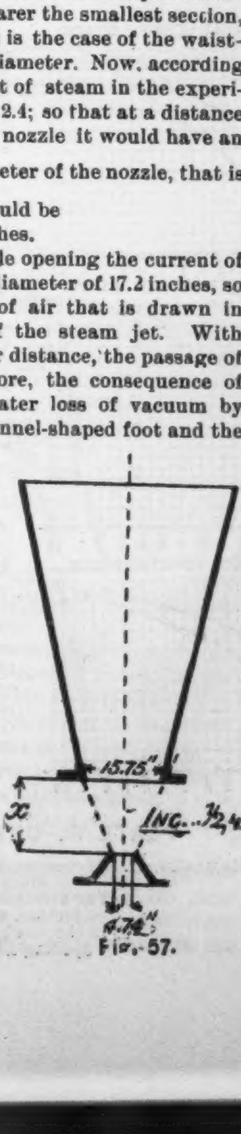


Fig. 57.

*Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen fur Gewerbe und Bauwesen.*

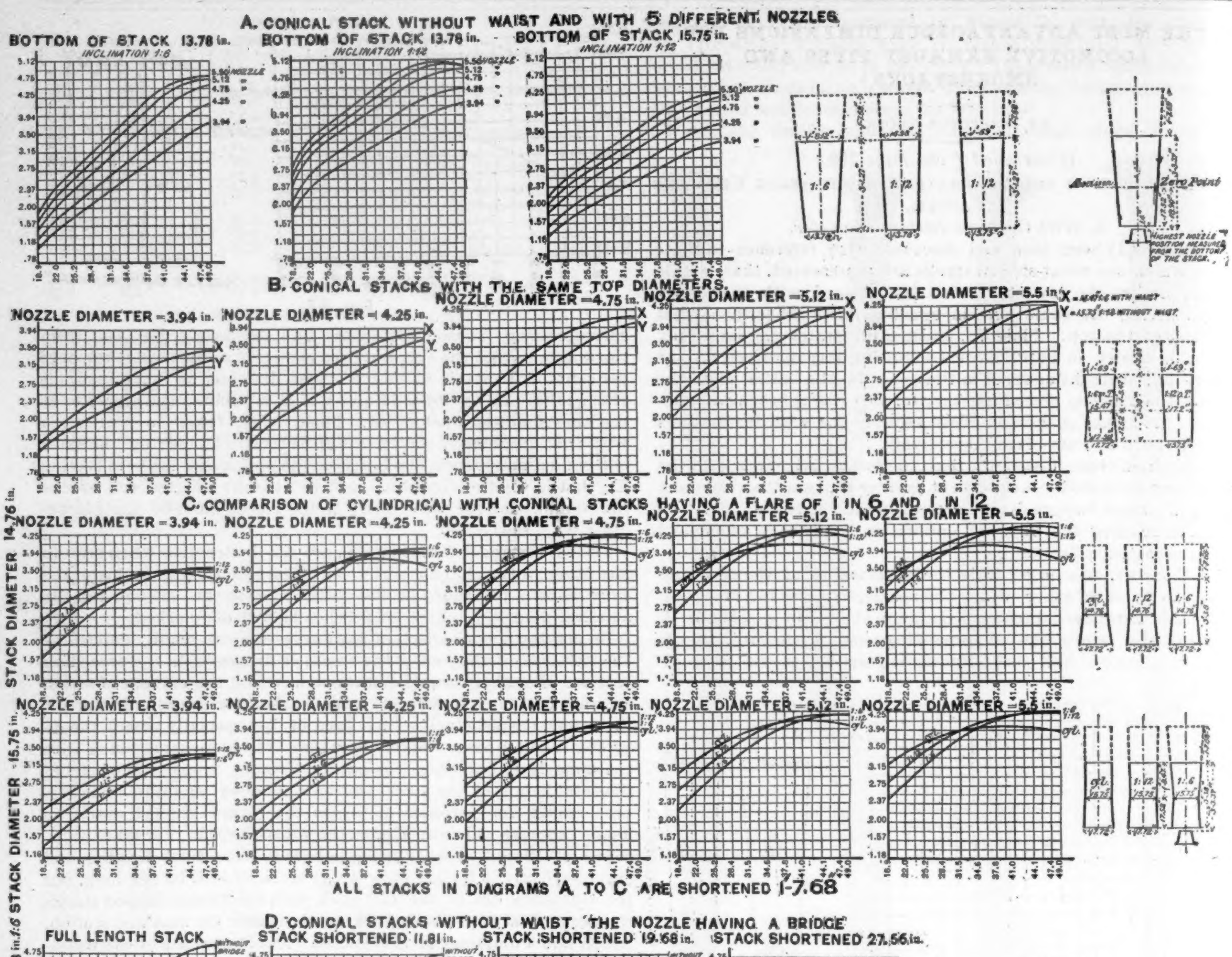


PLATE VI.—DETAIL DIAGRAM OF THE HANOVER SMOKE-STACK AND EXHAUST NOZZLE EXPERIMENTS.

REMARKS.—1. All observations with the water column were made with a constant steam pressure of 3.91 in. of mercury and with the same openings for the admission of air.

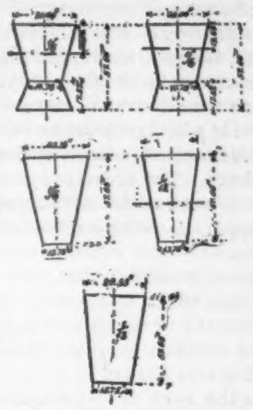
2. The abscissas, indicating the nozzle position, are all measured, on stacks without a waist from a point 17.52 in. above the smallest cross-section, and 18.9 in. above the highest position of the nozzle.

3. In the stacks represented under D, the nozzle without a bridge had an opening 4.74 in. in diameter, while the one with a bridge had an opening 5.12 in. in diameter; the breadth of the bridge being .63 in. Both nozzles thus had the same free opening.

TABLE XXII.

Comparison of the nozzle positions necessary to produce the same nozzle action (3.94 inches of water), the nozzle distance being measured from the smallest section of the stack, and the nozzle used being with and without a bridge.

Stack.		Nozzle without bridge.	Nozzle with bridge.	Shortening of the nozzle distance due to the use of the bridge.
Diameter and flare.	Length.	Inches.	Inches.	Inches.
14.76 inches (1/8) (With waist)	Full length	6.73	....	6.73
	Shortened 27.56 inches	25.32	11.14	14.17
15.75 inches (1/8) (With waist)	Full length	13.00	3.74	9.25
	Shortened 19.68 inches	23.43	10.83	12.60
13.78 inches (1/8) (Without waist)	Full length	17.44	10.83	6.61
	Shortened 11.81 inches	20.28	12.72	7.56
	" 19.68 "	22.32	14.92	7.40
	" 27.56 "	25.00	17.13	7.87
13.78 inches (1/12) (Without waist)	Full length	4.21	1.57	2.64
	Shortened 11.81 inches	9.84	3.15	6.69
	" 19.68 "	14.37	5.12	9.25
	" 27.56 "	19.29	10.43	8.86
15.75 inches (1/12) (Without waist)	Full length	19.02	12.01	7.01
	Shortened 11.81 inches	23.90	17.13	6.77
	" 19.68 "	28.74	20.87	7.87
	" 27.56 "	(43.90)	(32.87)	(11.02)



REMARKS.—When the stack 15.75 inches in diameter had been shortened 27.56 inches, it became impossible to maintain a vacuum of 3.94 inches any longer. The bracketed figures correspond to a vacuum of 3.54 inches.

in consequence of the reason given, and also of the loss previously shown in Fig. 44. With a stack 13.78 inches in diameter the same thing naturally occurs with a shorter nozzle distance, as shown under *C* in Plate V. The lines also assume the downward curvature earlier and more sharply than with the larger stack.

From these observations and from the conclusion reached above it follows:

That the efficient stack is long and that the nozzle distance should not be too great, say about .3 to .4 of the total height.

Too great a nozzle distance is to be especially avoided, especially on those locomotives hauling heavy trains, which at times work

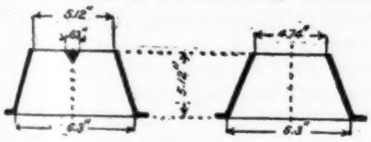


Fig. 58.

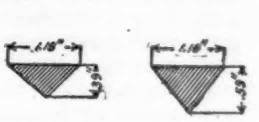


Fig. 59.

slowly and with a late cut-off. In this case the rush of steam receives a decided check, as each exhuust spreads out, after leaving the nozzle, somewhat more sharply than is the case with an uninterrupted current of steam. Therefore if, in such a locomotive, the smallest section is too high above the nozzle, it follows that, under such circumstances the steam does not enter it freely and the entrained air is held back so that the vacuum will be again lowered and the advantage aimed at with the long nozzle distance will be either partially or wholly lost.

VII.—EXPERIMENTS WITH A BRIDGE ACROSS THE NOZZLE.

In the first place, in the latter part of 1891, two four-coupled locomotives with bogie trucks were put in service on the Prussian State Railway, which were at first very poor steamers. An attempt was made to improve them by the use of a wedge-shaped cross-piece, called a bridge, having the sharp edge down.

The result was surprising and brought about a rapid application of the bridge to the large locomotives. The action of the bridge cannot be likened to a similar contraction of the nozzle, for the same thing was accomplished by the introduction of the bridge as is usually obtained in connection with an enlargement of the nozzle. It therefore became necessary to prove the advantage of the bridge on the apparatus to fix the reason for its action and to determine the best form to give it.

In order to shut out, once for all, the plea regarding the contraction of the exhaust nozzle, the same free opening was given to the nozzle with a bridge that the simple nozzle possessed. *Fig.* 58 shows the form and measurements given to the two nozzles, the breadth of the bridge being 0.63 inch. It was tested with all 18 of the experimental stacks, both full length and repeatedly shortened. The most important result obtained was to show that for stacks of small diameters and short nozzle distances the bridge either made no improvement at all or one that was very slight (see Plate VII., *A*, cylinder stacks having a diameter of 13.78 inches), while for greater distances it acted disadvantageously. It is, therefore, of considerable importance, if the stack is large and not too long and works so much the more, that it should be widened out somewhat at the top. The principal advantage of the bridge is seen to lie in the fact that, for the same amount of work, the necessary nozzle distance can be very considerably shortened. This is especially to be considered in the case of locomotives whose boilers are high, in

FIG. 60.

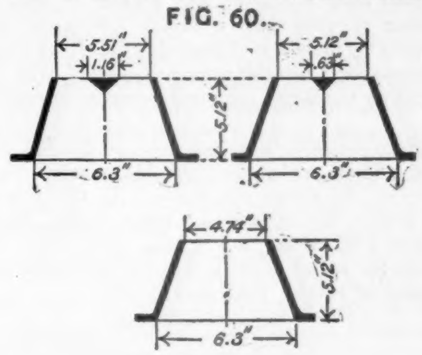


FIG. 61.

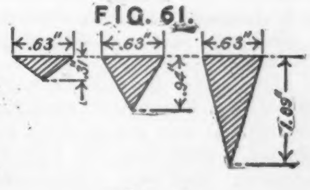
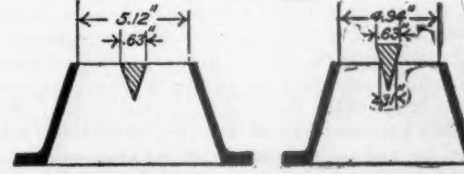


FIG. 62.



which the total height of the stack is comparatively short on account of the other conditions surrounding it.

In order to make this perfectly clear, reference is again made to the diagrams of the experiments with funnel-shaped stacks given in Plate VI. under *D*. Here there are shown the two stacks of 13.78 inches diameter having flares respectively of 1/8 and 1/12 as well as the one of 15.75 inches diameter with a flare of 1/12, each being represented in four different lengths. (It is to be noted here again that 17.52 inches must be taken from the abscissa given in this plate, if we wish to determine the distance of the nozzles from the smallest section of the stack.)

From Plate VI. and VII., it will be seen that a satisfactory action of the bridge is only obtained at certain fixed positions of the nozzle, and that when this distance is increased, the shorter and larger the stack must be made and, above all, the sharper must be the

flare. In order that a comparison may be made of this action for various forms of stacks, the figures for several coincal stacks of different diameters and lengths are brought together in Table XXII.

The last column of this table shows very clearly what advantage there is to be gained by the use of the bridge, for it will be seen that in some forms of stack the adjustment of the nozzle position can be shortened 14.17 inches without detracting in any way from the efficiency of the blast. In like manner the action of a locomotive's draft can be considerably increased by the application of the bridge, the position remaining unchanged, and that, too, without contracting the nozzle. If this is not necessary, because the locomotive already makes steam enough, then the stack can be enlarged if a bridge is used. This was practically demonstrated by applications made to six and eight-wheeled engines at the Tempelhof shops. The accompanying Table XXIII.* gives the increase of draft in comparison with an ordinary nozzle, that was obtained on the apparatus with a series of nozzle distances and with different stacks.

We see from this that there are circumstances under which with the same nozzle distance an increase in efficiency of 90 per cent. can be obtained by using a bridge. The most efficient point of action of the bridge of a given diameter, length and sharply contracted stack is also shown.

For the sake of determining the best form, experiments were made with five different bridges. In this work the width was kept the same. First two bridges like those shown in Fig. 59 were tried upon the apparatus; they had a common width of 1.16 inches, and a depth of .39 and .59 inches respectively on a nozzle with a diameter of 5.51 inches. The free sectional area for the passage of the steam was then exactly the same as that previously used in a nozzle 5.12 inches in diameter with a bridge .63 wide and was also the same as that of a simple nozzle 4.74 inches in diameter, as shown in Fig. 60. In all of these experiments it was clearly shown that the stacks, whether their diameter was greater or less, not only produced a lower vacuum with a bridge 1.16 inches wide, but also threw considerably more water than they did with a narrower bridge and a correspondingly smaller nozzle diameter. The jet of steam was consequently too large for the corresponding sectional area of the stack.

The experiments could, therefore, well be limited to bridges .63 inches wide. They were consequently carried on with three different depths, as shown in Fig. 61. In the lowest, having a depth of .31 inches, the apex was a right angle. The results are shown in Plate VII., under II. In that place only five stacks are given, because the ratios of the bridges to each other, as well as to the other forms of stacks, were exactly alike.

(To be Continued.)

*This table we are compelled to omit this month. It will appear in our next issue.—Ed.

New Publications.

THE WISCONSIN ENGINEER. *University of Wisconsin Engineering Journal, Madison, Wis.* Published quarterly; $1.50 per year. Pages 6¾ by 9¾ inches.

The first issue of this journal is dated June, 1896, and contains 90 pages of interesting and instructive reading matter covering a wide range of subjects. It also contains an index to current engineering periodicals, embracing the period from Dec 5, 1895, to April, 1896, inclusive. This new engineering index is compiled without any description or digest of the articles mentioned in it, and for that reason we think it will be found to fall short of what is usually required. The titles of some articles are a pretty good indication of their contents, while others are very "non-committal" and need an explanatory note or phrase to enable the seeker after information to judge of the value of the article to him. But it may be that we don't know as much as we think we do about what an index ought to be, and we certainly wish the new enterprise all the success to which it aspires. The articles in its reading pages are certainly of a high standard, and if maintained in succeeding issues will place the *Wisconsin Engineer* among the best of the technical periodicals published in connection with engineering colleges.

AIR BRAKE CATECHISM. By C. B. Conger. Ninth Thousand. *Locomotive Engineering.* New York. 96 pages, 3½ by 6 inches. 25 cents.

That there is a demand for this kind of a book is indicated by the fact that the copy before us is one of the ninth thousand that has been published. As suggested by its title, it is written in the form of question and answer, which has some decided advantages in a book of this kind. It is difficult to understand, though, why writers of this kind of "practical" books omit the definite article. Here is an example from the book before us, with hyphens inserted where the article has been omitted. "If (——) train pipe leaks (——) brake will continue to set tighter when (——) brake valve is put on lap, and stop the train before you want it to." There seems to be an idea in some authors of such books that it gives a more distinctly technical character to what they write if the article referred to is omitted.

Some of the engravings in the book are very bad. How any one not familiar with the construction of the engineer's brake valve can learn anything from the smudgy engraving which the publishers have seen fit to put on page 20 any one would be at a less to know. The lettering too in this illustration is very bad. Another fault is that sometimes as many as three separate inquiries are embodied in one of the questions. A novice cannot easily retain these in his mind so as to understand the following answers. The binding of the book is simply infuriating. The leaves are fastened together with wire, and the publishers ought to provide the reader with a small "jemmy" or "pinch-bar" to pry the leaves apart. The index at the end is unworthy of the name, as it gives only 32 terms with the pages in which they are referred to. In a book of this kind a good index is very essential. In speaking of the book generally it cannot be said that lucidity is one of its marked characteristics. A novice, it is thought, will be puzzled a good deal to understand some of the explanations.

Doubtless the book is more susceptible of understanding when used and read on a locomotive or in the shops where the objects explained can constantly be referred to, than it is when such reference is impossible.

WESTINGHOUSE ELECTRIC STREET CAR EQUIPMENTS. *Containing a Description of the Various Motors, Controller and Other Electric Street Car Apparatus Manufactured by the Westinghouse Electric and Manufacturing Company, with Detailed Instructions for the Operation, Inspection and Repair of same; also full Directions for Locating and Remedying Faults.* By Frederick L. Hutchinson and Leo A. Phillips, East Pittsburgh, Pa. 91 pages, 4¾ by 7 inches. ($1.)

The sub-title of this book gives a tolerably good idea of its scope and character. In the preface the authors say further that its "object is to give a complete description of the various street-car motors and car equipment apparatus manufactured by the Westinghouse Electric and Manufacturing Company; to give complete directions for the proper inspection and repair of the same; to explain in detail the operations of the various devices, and also to give explicit instructions for locating and remedying any electrical trouble that may be encouncered. The writers have endeavored to put all directions, diagrams and illustrations in such form as to be readily understood by any ordinary man, without previous electrical training, and have aimed to give practical rather than theoretical information." The titles of the chapters are "Electrical Units and Terms"; "Description of Westinghouse Street Car Motors"; "Description of Controllers and Other Car Apparatus"; "Operating of the Car Equipment"; "Inspection"; "How to Locate and Remedy Faults"; "Repairs, Rewinding Armatures, etc."

The book is admirably printed, illustrated and bound in limp covers, which invite perusal.

A PRACTICAL HANDBOOK ON THE CARE AND MANAGEMENT OF GAS ENGINES. By G. Lieckfeld, C. E.; authorized translation by G. Richmond, M. E. (with instructions for running oil engines). Spon & Chamberlain, 12 Cortlandt street, New York. 103 pages. ($1.50.)

As the name indicates, this book does not dwell upon the theory of the gas engine, but furnishes the reader with practical information on the purchase, installation and operation of this type of motor. The first chapter is on choosing and installing a gas engine, and tells how to judge the design, workmanship, correctness of running, economy, reliability and durability, etc. The items involved in the first cost of a gas engine installation are enumerated, also the items under the expense of operating. The character of the foundations, arrangements of piping and the precautions to be observed in setting up the engine are also discussed in this chapter. The second chapter is devoted to brakes and their use in ascertaining the power of gas engines. In connection with the work of testing the "brake power" and "indicated power" are defined and compared, and the distribution of heat in the gas engine briefly stated. The third chapter is on the attendance on gas engines, and gives instructions on starting, stopping, oiling, cleaning, etc. The next chapter takes up the different kinds of defects that are liable to develop in operation, and tells what should be done in each case. This chapter is quite complete, and is written in a practical vein, as is all of the book, for that matter. It is followed by a chapter on dangers and precautionary measures in handling gas engines. The last chapter is one of 12 pages on oil engines, and is devoted chiefly to the Hornsby-Akroyd engine. The little book will be found of genuine practical value to those operating gas or oil engines, or about to purchase or install them.

Water-Tube Boilers.*

BY J. WATT.

Some years ago the writer had the honor of reading a paper on the subject of water-tube boilers before the Liverpool Polytechnic Society, and, after enumerating the points which constituted a good water-tube boiler, deduced therefrom the following rules or laws, which should be observed in designing a trustworthy steam generator. They were as follows:

1. The tubes should be arranged in a position to absorb the greatest amount of heat, by causing the flame to travel in an upward direction at right angles to their axis.
2. The tubes should be in a horizontal or inclined position, as the most efficient to emit heat.
3. The steam generated should have free and unobstructed escape to the steam receiver.
4. The circulation or supply of water to the tubes must be copious to prevent overheating.

These are the theoretical, and form the essential, conditions of an efficient water-tube steam boiler.

But, in addition to these, there is another not the less important which concerns the practical part or life of a boiler, namely, the facilities for inspection, cleaning and repairing.

It is 22 years ago since the above was written, and, although old, it is quite as applicable to-day as then, and as far as the writer's experience goes, quite borne out by practice.

It is not the writer's intention of going over the whole range of this subject of water-tube boilers, but to lay before you the result of a few experiments, which may elucidate and explain some of the mysterious circumstances connected with this complex subject.

The experiments were made with a small model boiler (see Figs. 1 and 2) containing 39 straight tubes, each ⅝ inches in diameter by 9 inches long, containing 2.9 square feet of heating surface. The receivers to which the tubes were attached were flat, the end plates were of glass, so that the tubes could be seen right through and the action going on inside could be distintly observed. A steam receiver was also placed on the top, connecting the two other receivers. Heat was supplied by two Bunsen burners, consisting of two tubes with cross slots, the heating taking place being very much similar to that of an ordinary firegrate burner. The model was so constructed that it could be used or tried in a great number of different positions.

The first series of experiments was made with a view of finding out the relative value of heating surface when the tubes were angled from a horizontal position gradually to that of a vertical one, or through an angle of 90 degrees. The experiments were conducted at atmospheric pressure, and commenced by first raising a

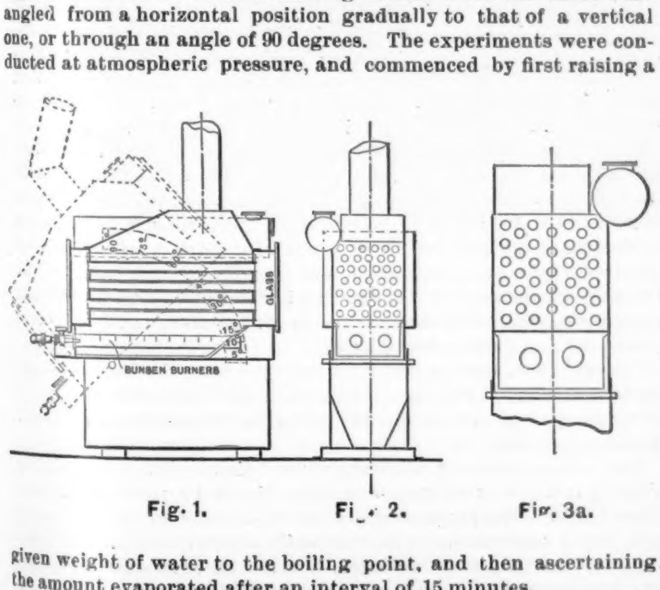


Fig. 1. Fi_. 2. Fig. 3a.

given weight of water to the boiling point, and then ascertaining the amount evaporated after an interval of 15 minutes.

After a few preliminary trials, it was found that when the boiler was angled about 10 degrees from the horizontal the evaporation was highest, viz., 8½ ounces; when the angle was increased to 15 degrees, the evaporation was 8¼ ounces; 30 degrees, 7½ ounces, 45 degrees, 6½ ounces; 60 degrees, 5¾ ounces; 75 degrees, 5⅛ ounces; and 90 degrees, 5 ounces. Again on reducing the angle to 5 degrees, the evaporation was 8¼ ounces, and when level 7½ ounces. It may be here stated that owing to the pressure of gas varying a little, very seldom the same results could exactly be arrived at, but by making several trials the above is a fair average. This is graphically represented in Fig. 3 (top curve); the vertical ordinates representing the percentage of evaporation at the various angles at which the boiler was tried beginning at the horizontal position and gradually rising to the vertical position. It was found when the boiler was angled 10 degrees it gave the best result; therefore 10 degrees represents the maximum evaporation, or 100 per cent.

In looking at this diagram, we find that in any water-tube boiler whose tubes are inclined, say 10 degrees, by merely increasing the angle to 30 degrees the amount of water evaporated is reduced from 100 to 85, or 15 per cent. less. If the angle be increased to 60 degrees the decrease will be 33 per cent; and at 90 degrees, or the tubes vertical, the reduction is a little over 40 per cent. This compares very favorably with the old-fashioned rule employed in the ordinary steam boiler of allowing 2 square feet of vertical heating surface to be of equal value to each 1 of horizontal.

These experiments were conducted with the tubes placed in horizontal rows, so as to allow the products of combustion to travel in a zigzag direction to the funnel. The next series were taken with the boiler turned on its side, so as to form the tubes into vertical

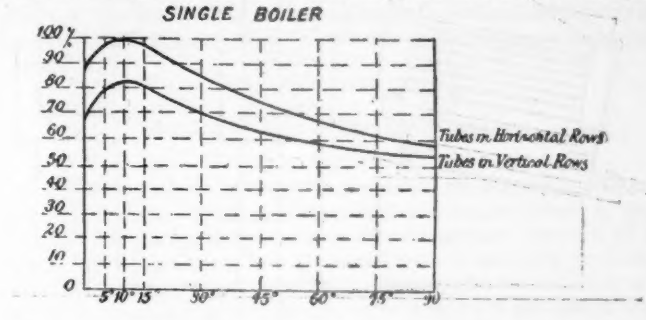


FIG. 3.

rows, and giving the products of combustion a more direct course to the funnel (see Fig. 3a). The result is shown by the lower curve on Fig. 3. The highest percentage was 82 per cent. at 10 degrees and 53 per cent. at 90 degrees, the best result showing a difference of 18 per cent. in favor of the former arrangement of tubes.

Instructive as these tests may be, the next series will show still more striking results. In order to arrive at the duty performed by various tubes or rows of tubes, and more especially those nearest to the source of heat, if we take another boiler—or, rather, a part of a boiler representing that row of tubes which is nearest to the fire—and place the two together, as represented in Fig. 4, we have the means of arriving at the evaporation of each boiler separately. This small boiler consists of six tubes only, having a heating surface of .44 square feet, compared with the larger one of 2.9 square feet, or a combined heating surface of 3.34 square feet.

The results of this arrangement are represented on diagram Fig. 5. The upper curve shows the combined evaporation of both boilers, and although there is an augmented heating surface of about 15 per cent., yet there is very little difference in the amount evaporated. The lower curve shows the evaporation of the original or larger boiler, and we now see that at its best it is reduced from 100 per cent. to 40 per cent, at 10 degrees, and from 60 per cent. to 17 per cent. at 90 degrees. On the other hand, the small boiler is represented by the middle curve, and its evaporation at its best is 60 per cent. at 10 degrees, and 45 per cent. at 90 degrees. The above results may be stated in other words, namely, that practically 60 per cent. of all the steam generated in any water-tube boiler with tubes at any angle is generated in the first or nearest row of tubes to the fire. The remaining 40 per cent. is left for the larger portion of the boiler to accomplish.

By reversing the positions of the two boilers—by placing the smaller on top of the larger one—we can arrive at the evaporation of the top row; but this was found to be so small as not to be taken notice of. The writer had not the means of testing the intermediate rows; but the following table will not be very far off:

1st row nearest to the fire evaporated	60.0	p. c. of the total evaporation.
2d " " " " "	24.0	" " " "
3d " " " " "	9.5	" " " "
4th " " " " "	3.5	" " " "
5th " " " " "	1.5	" " " "
6th " " " " "	1.0	" " " "
7th " " " " "	0.5	" " " "
	100.0	

The importance of the above cannot be overlooked. Either the first row is doing too much, or the back row too little; and the conclusion arrived at is that, practically, the first row is receiving the whole wear and tear of the boiler, therefore more

* From a paper read before the (British) Institution of Naval Architects, March 26, 1896.

liable to damage and renewals. This has proved itself in the case of copper tubes, which, although a better conductor of heat than either iron or steel, yet were unable to stand the severe work they had to perform. The danger from overheating and rupture is not only very unpleasant from a stokehole point of view, but the giving way at some critical moment demands our most important consideration; in short, it is the vital part of the water-tube boiler.

Seeing this difficulty some time ago, the writer devised some means by which the first row was relieved of this heavy duty, and more laid on those immediately behind. This is accomplished by substituting tubes of much larger diameter nearest to the fire than those which are more remote. The larger tubes contain more water, and present less heating surface for the space occupied than those of smaller diameter. The result is that the evaporation is less

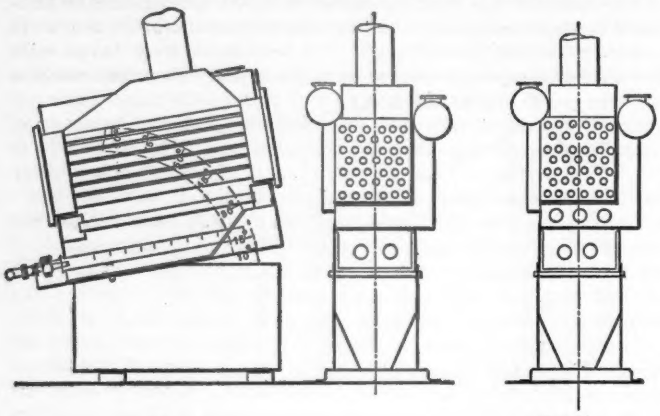


Fig. 4. Fig. 6.

with the larger tubes, but greater with the smaller. Fig. 6 represents the arrangement. For the six ⅝-inch tubes we now adopt three ¾-inch tubes in their place. The weight of water in the three tubes is double that in the six smaller ones, while the heating surface remains the same. The diagram representing the results of the trials is shown on Fig. 7, the top curve, as before, representing the results of the two boilers. Practically there is very little difference compared with the similar top curves of Figs. 3 and 5; if anything, it is slightly in favor of Fig. 7. But when we come to compare the two lower curves with the similar curves in Fig. 5, we find that they have almost changed places. Taking the top or larger boiler, the evaporation at 10 degrees is nearly 60 per cent. of the total, as compared with a little over 40 per cent. shown on the former trial, the curve dropping down at 90 degrees to 27 per cent., against 17 per cent. Taking the lower boiler, representing the three large tubes, the evaporation is reduced from 60 per cent. to a little over 40 per cent. at 10 degrees with the larger tubes, terminating at 38 per cent. at 90 degrees. It will be observed that the two curves cross each other when the boiler is at an angle of about 55 degrees, showing that the evaporation at this angle is about equal in each boiler. We here see that the evaporation in the first row of tubes is very much reduced, there is less liability to overheating, and accidents are reduced to a minimum.

COMBINED BOILER WITH SMALL BOTTOM TUBES

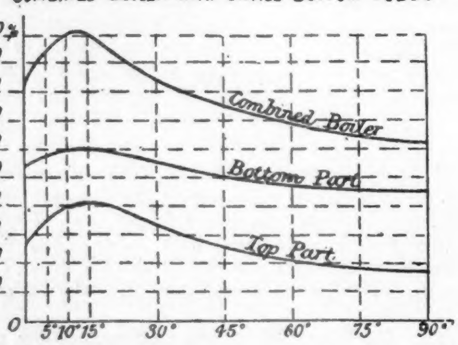


Fig. 5.

The quantity of warer evaporated by the first row of small tubes was at the rate of 5 pounds per square foot of heating surface per hour, and the velocity at the end of the tubes about 3.8 feet per second. The tubes were full of semi-steam and water, so that no

COMBINED BOILER WITH LARGE BOTTOM TUBES

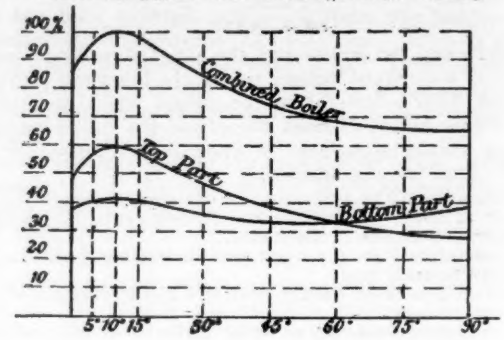


Fig. 7

light could be seen at the other end; evidently these tubes were evaporating their maximum quantity with efficiency.

On the other hand, with the row of large bottom tubes, the rate of evaporation was about 3.5 pounds per square foot heating surface, and the velocity at the tube ends (steam only) about 2.9 feet per second. Up to an angle of about 60 degrees a light could be distinctly seen through these tubes, the steam occupying about one-third of the area on the top side, the water underneath presenting a clear, solid mass. Above 60 degrees elevation the water and steam became more or less mixed up, so that a light could not be seen at the other end.

It must be remembered that the above trials were made at a pressure of 1 atmosphere where the relative volumes of steam and water are as 1,640 to 1. For higher pressures a corresponding rate of combustion may be adopted.

The most vital parts in any water-tube boiler, and the most easily damaged by overheating, are those tubes in close proximity to the fire. To overcome this difficulty two courses are open—(*a*) by adopting small tubes and providing for a vigorous circulation; (*b*) by adopting larger tubes and a less active circulation. Adopting the former, there is a limit both in respect to the speed of the current and the quantity of steam in contact with the heating surfaces. According to Mr. Thornycroft's experiments, at a pressure of 3 atmospheres the relative volume of steam and water passing through a number of 1⅛-inch tubes was about 5.4 to 1, and at 12 atmospheres this would equal 1⅛ to 1, or three volumes of steam, at an average, in each tube, to two of water, a condition of things which presents to us two evils; one is the danger arising from the tube becoming much hotter than the temperature due to the pressure. As an instance of this, there is the failure of copper tubes in water-tube boilers to stand this excessive heat. The second evil is the slow corrosion taking place, owing to part of the steam in contact with the tube becoming decomposed at a high temperature, forming oxide of iron and hydrogen gas. By the improved arrangement of larger tubes to face the first and direct action of the fire, a larger body of more solid water is in actual contact with the heating surfaces; the liability to damage by overheating is reduced to a minimum; the duty of the various tubes more evenly distributed, and the steam generated more freely disengaged.

In conclusion, there is one point which, during the time these experiments were being made, confirmed the writer's views more strongly of a grave defect in Belleville water-tube boilers for marine purposes.

The arrangement of all water-tube boilers with horizontal or slightly inclined tubes, on board ship, should be parallel with the line of keel. But it appears to be the rule, so far as this boiler in question is concerned, to place the same across the ship. Now, the inclination or angle of the Belleville boiler tubes is about 2 degrees or 3 degrees from the horizontal, and as 10 degrees, say, is not an uncommon angle for a ship to roll at sea, it follows that the tubes will become depressed, or angle reversed, to the extent of 7 degrees or 8 degrees.

A ship to roll from eight to ten rolls per minute is not uncommon, and therefore six or eight seconds would be the duration of one roll.

Now, imagine the ship rolling, a heavy fire on the grate, and in this time these lower tubes, generating, as we have seen, such a large volume of steam, which would immediately reverse the circulating current, fill the upper ends, and be here imprisoned, only to be relieved by the next roll. The greater portion of the steam will now be transferred to the other end, to be again reimprisoned, and so on until the ship gets into lest turbulent waters. With reference to what the continued effect on these semi-dry tubes would be in a sea way, or in the event of the ship having a list, the result is left for your better and impartial judgment.

The Eighth Statistical Report of the Interstate Commerce Commission.

The advance sheets of the eighth statistical report of the Interstate Commerce Commission have been received. Although hoary with age, relating as they do to the year from July 1, 1894, to June 30, 1895, we will follow the custom of quoting a few of the figures.

On June 30, 1895, 169 roads, operating 37,855 miles of track, were in the hands of receivers, 23 roads and 2,963 miles less than 12 months previous. The total mileage in the United States on that date was 180,657.47 miles. During the year covered by the report 14 roads were abandoned, 9 merged, 32 re-organized, and 28 consolidated. There was on June 30, 1895, 1,965 railway corporations of which 1,013 maintained operating accounts. The total number of locomotives in service were 35,699. Of this number 9,999 were passenger locomotives, 20,012 freight locomotives, 5,100 switching locomotives and the remainder unclassified.

The total number of cars reported was 1,270,561, of which 33,112 were passenger cars, 1,196,119 were freight cars, and 41,330 were used by the roads in their own service. These figures do not include private car-line equipment. The number of passengers carried per passenger locomotive was 50,747, or 3,907 less than in 1894. The number of passenger-miles per passenger locomotive was 1,218,967, or 225,433 less than in 1894, while the number of passenger cars per 1,000,000 passengers carried was 65, or 12 greater than the preceding year. This is probably largely due to decreased travel on account of business depression, but it also suggests that passenger traffic has returned to its normal condition previous to the World's Columbian Exposition. The number of tons of freight carried per freight locomotive in 1895 was 34,817, showing an increase of 2,908 when compared with the corresponding figures for 1894. The number of ton-miles per freight locomotive was 4,258,821, the increase over the previous year being 242,066. These figures indicate increased economy in transportation of freight. The same result is shown by the fact that 1,888 freight cars were required to move 1,000,000 tons of freight in 1894, and 1,717 in 1895. These figures, however, are not satisfactory, because the basis of the computations does not include cars not owned by railway companies, in which a large proportion of freight is transported.

Out of a total equipment of 1,306,260 locomotives and cars, only 362,498 were fitted with train brakes, and 408,856 with automatic couplers on June 30, 1895. The increase in equipment fitted with train brakes was 31,506; with automatic couplers, 51,235. On June 30, 1895, the number of passenger cars in service was 33,112, of which 32,384 were fitted with train brakes, and 31,971 with automatic couplers. The number of freight cars in service was 1,196,119, of which 295,073 were fitted with train brakes and 366,985 with automatic couplers.

The number of men employed by railways shows an increase of of 5,426, as compared with last year, the number of employees being 785,034 on June 30, 1895.

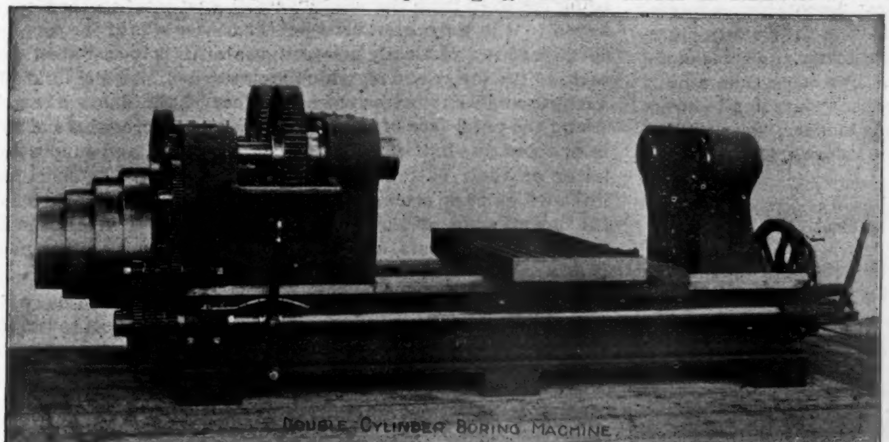
The number of passengers carried by the railways during the year ending June 30, 1895, was 507,421,362. The number of passengers reported as carried one mile was 12,188,456,271. The number of tons of freight carried as reported by railways was 696,761,171. The number of tons carried one mile was returned as 85,227,515,891, indicating an increase of 4,892,411,189.

The gross earnings of the railways for the year ending June 30, 1895, were $1,075,371,462. The expenses of operation for the same period were $725,720,415, which were $5,693,907 less than for 1894. The important unit in railway statistics designated as the coefficient of operating expenses, that is, the percentage of operating expenses to operating income, for 1895, was 67.48 per cent. The amount of railway capital on June 30, 1895, is shown to be $10,985,203,125, or $63,330 per mile of line. The increase during the year was $188,729,312.

The number of railway employees killed during the year was 1,811, and the number injured was 25,696. The number of passengers killed was 170, the number injured, 2,375. One employee was killed for each 433 employed, and one employee was injured for each 31 employed. Of the class of employees known as trainmen, that is, engineers, firemen, conductors and other employees whose service is upon trains, it appears that one was killed for each 155 in service, and one injured for each 11 in service. The number of passengers carried for each passenger killed during the year was 2,984,832, and the number carried for each passenger injured was 213,651. The liability of passengers to accidents is better shown in the fact that 71,696,743 passenger-miles were accomplished for every passenger killed, and 5,131,977 passenger-miles for every passenger injured.

Double Cylinder Boring Machine.

The machine shown herewith is designed for rapidly boring two cylinders at once. It is peculiarly useful in works where a large number of cylinders of the same or nearly the same size are to be bored. The machine is usually made with a bed 11½ feet long, fitted with a head stock carrying two heavy spindles 5 inches to 9 inches in diameter with bearings adjustable for wear, placed with their centers 31 inches apart horizontally. These spindles are driven by a 30-inch cone pulley with four steps for 3-inch belt, geared 15 times. The boring bars are inserted in these spindles and have their outer ends supported in a double tail stock fitted with removable bushings and adjustable upon the bed.



Double Cylinder Boring Machine.

The work table is 66 inches by 43 inches, which dimensions, however, can be varied when required. The table traverses by hand or power, 45 inches upon the bed. It has four automatic feeds ranging from $\frac{1}{32}$ to $\frac{1}{8}$ of an inch. These feeds can be changed at slight expense to any desired figures, and the bed can be lengthened or shortened within reasonable limits, to suit requirements. From the top of the table to the center of the spindles is 18 inches, and the bed is 5 inches below the top of the table. The total swing over the bed is 48 inches, and over the table 38 inches.

This special machine has been designed by Messrs. Bement, Miles & Company, of Philadelphia. It is particularly useful in shops where large numbers of small cylinders are being manufactured. One of these machines has lately been installed in shops where they are manufacturing air compressors, rock drills and similar work. It has proven in this connection very efficient and satisfactory.

A New Dynamometer.

Consul Doederlein, of Leipsic, calls attention to a new dynamometer invented by Mr. von Pittler, in Germany. This dynamometer, so it is claimed, is of equal value as an instrument for power lessors and power lessees. The construction is extremely simple, as all delicate parts are excluded. It is available as an independent apparatus for the measurement of power, either of individual machines or of a whole establishment. It can, furthermore, be used as an intermediate countershaft, and is, as such, in addition to its qualities as a dynamometer, an excellent elastic impulsion, especially for electric motors.

Just in the same way as this dynamometer can be used as a countershaft, it can also be connected with the shafting. The actual cost is so low that we must regard it, on account of its

good qualities, as a necessary part of a shafting—as a part that everybody in possession of a mechanical motive power must of necessity have, if he desires to utilize such power to advantage. The dynamometer can be easily handled and controlled by anybody, whether expert or layman.

The consumption of motive force, be it fuel (in the shape of coal, steam, hot air, oil, etc.), water power or electricity, can be controlled per absorbed power unit, so that both power lessor and power lessee can check off the consumption of power at any time, say weekly, monthly or yearly, in the most precise manner.

It has also been observed by Mr. von Pittler, by means of his apparatus, that the amount of labor performed in his factory each day from 7 to 9 o'clock a. m. was proportionately less than from 9 to 12 o'clock a. m. It was found that this difference was due to the fact that the foreman came to the factory at 9 o'clock. Again, the record kept by Mr. von Pittler shows that the amount of labor on Fridays, Saturdays and Mondays was 800,000 meter kilograms less than other days, whereas on Thursday—the day before pay day—the largest amount of labor was performed.

Mr. von Pittler, who has the counting apparatus adjusted to one side of his office desk, thereby keeping control over the work of his machines, can also very easily ascertain the difference in the amount of coal used before and after cleaning the boilers.—*U. S. Consular Notes.*

The Origin of the Word Derrick.

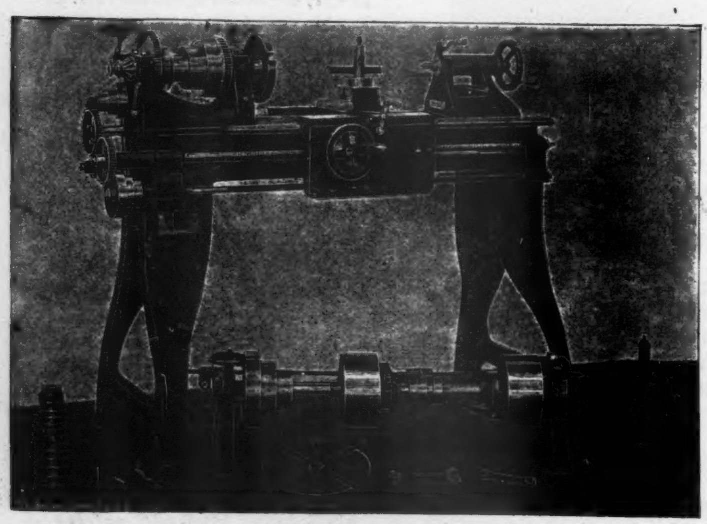
How many mechanics or engineers have ever heard how this word originated? The following is taken from an "exchange":

"In mechanical matters the name of the familiar "derrick," a very common form of crane, has not the most honorable pedigree. Derrick was indeed nothing more exalted than the Tyburn hangman of the early part of the seventeenth century, and his name figures frequently in plays of the period. For more than a hundred years he gave his name to gibbets, whose "elevating" powers were applied in a more useful direction in the modern "derrick."

Webster says the word originally meant a gallows, from a hangman named *Derrick.*

The Wagner 12-Inch Lathe.

The accompanying illustration is of a 12-inch lathe built by the A. P. Wagner Tool Works, Sidney, O. This firm build a line of lathes similar to this one in sizes from 8 to 18 inches. They are strong and well built, and the makers claim they are second to



12-in. x 4½-ft. Bed Screw and Rod Feed Lathe with Three-Speed Cone.

none in the market. The head stocks and tail stocks are not cored out at all, but are solid. The spindles are of the best hammered steel, accurately ground, and they run in phosphor bronze bearings. The reverse and cone gear are cut out of solid steel. The carriage is gibbed front and back and has extra large bearings its entire length, and is arranged for side facing. All sliding parts are accurately scraped to a bearing. The 12-inch lathes are furnished complete with steady rest, large and small face plates, centers finished drop-forged, and a full set of standard change gear; also with a plain rest, a compound rest, plain foot power or bicycle foot power, friction countershaft or plain countershaft. Some of the important dimensions of the 12-inch lathe are as follows:

Swings over bed	13 inches
Swings over carriage	8⅝ inches
Swings over plain or compound rest	7⅞ inches
Diameter of three-speed cone	6⅛, 4¾, 3 inches
Diameter of four-speed cone	6¾, 9½, 4½, 3 inches
Width of belt on cones	2 inches
Diameter of head spindle	$1\frac{1}{16}$ inches
Hole through spindle (standard)	$\frac{11}{16}$ inches
Front bearing of spindle	$1\frac{11}{16}$ by 3⅞ inches
Back bearing of spindle	$1\frac{7}{16}$ by 2⅛ inches
Diameter of tail spindle	$1\frac{6}{16}$ inches
Will cut screws	2 to 40 threads per inch
Will cut pipe threads	41½ threads per inch
Speed of countershaft	180 revolutions
Size of countershaft pulleys	8 by 4 inches
4½-foot lathe takes between centers	24 inches
Weight of 4½-foot lathe for domestic shipment, about	1,050 pounds
Weight of 4½-foot lathe for foreign shipment, about	1,450 pounds
Beds made in lengths of	4½, 5½, 6½ feet

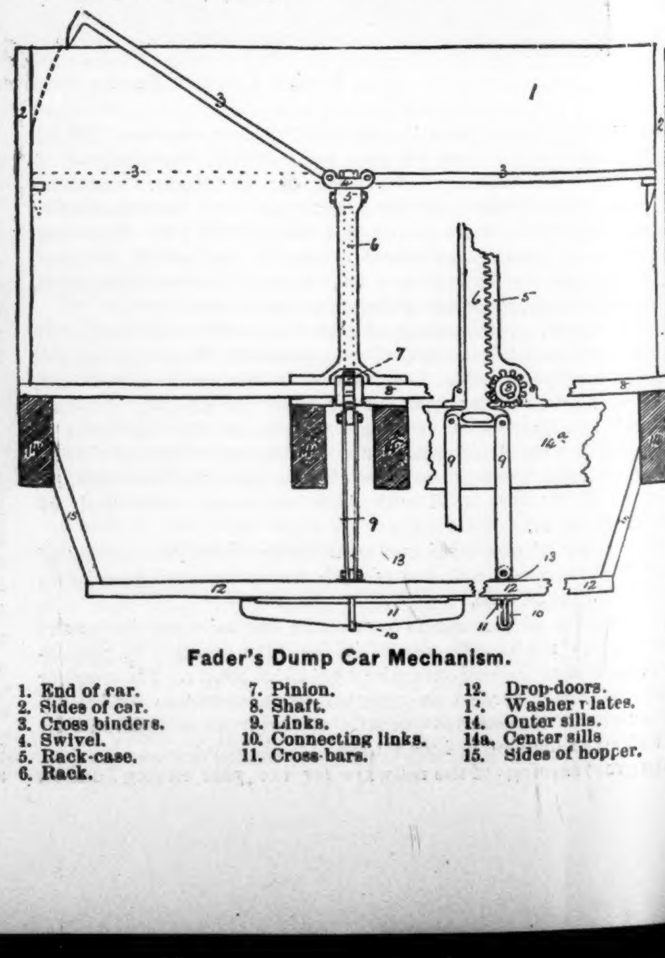
This company has an entirely new plant heated by steam and lighted by its own electric-light plant. All its machinery is modern, and the excellent facilities are supplemented by a rigid inspection of all work. The concern also builds a full line of plain and automatic turret lathes.

Its new catalogue, just issued, is printed in English, German, Spanish and French, and will be sent on application. The orders this company has received for its machines are so numerous that it is running its works double time.

The Fader Dump Car.

The Fader device for operating the drop doors of a hopper-bottom car is shown in the accompanying drawing. It can be readily fitted to any ordinary hopper-bottom car without material alteration of the car. The chains by which the doors are usually operated being removed from the shaft, a small cast-steel toothed-pinion is keyed to it in the center, between the center sills of the car; against this, traveling vertically between the sills is a cast-steel toothed-rack, to the lower end of which are attached parallel links of such a length as just to touch the inner face of the doors when closed. Along the outer face of the two doors are two cross-bars of flat bar-iron, about one-half of the length of the doors, and supporting the latter at their extreme ends; passing through the doors are two links which pass around these cross-bars and connect them with the lower ends of the longer links. By this arrangement the weight of the doors and the load is at twice as many points as would be the case if the links were directly connected to the doors.

Fitting over the rack and pinion and acting both as guide and stop to the former is a case of malleable iron bolted to the sills of the car. This case is made in halves, so that either part may easily be removed when necessary.



Fader's Dump Car Mechanism.

1. End of car.	7. Pinion.	12. Drop-doors.
2. Sides of car.	8. Shaft.	13. Washer plates.
3. Cross binders.	9. Links.	14. Outer sills.
4. Swivel.	10. Connecting links.	14a. Center sills
5. Rack-case.	11. Cross-bars.	15. Sides of hopper.
6. Rack.		

At the top of the rack-case is the square head of a bolt to which is fastened a swivel with two long wrought-iron cross-binders (or arms with hooked ends) hinged to it, designed to engage in eyes fixed to the inner surface of the sides of the cars, to prevent their bulging when loaded with coal or material of a like nature. When the car is loaded with lumber, or any material not liable to cause bulging, the cross-binders may be unhooked, the swivel turned round longitudinally in the cars and the arms thrown upright across one another (for which purpose they are each provided with a slight off-set), or they may be allowed to hang down between the twin longitudinals; in either case they are well out of the way and occupy but little space in the car. The ratchet and pawl and wrench now in use may still be utilized.

Some of the special features claimed for the car are: 1. Though the power is applied centrally the weight of the doors is divided equally between two points at or nearly opposite the hinges. 2. In case of the doors being jammed or frozen together it is possible to force them down from the interior, the downward movement of the rack transmitting a similar movement to the bar-links which rest on the inner surface of the doors. 3. The removable cross binders supply the advantage of fixed cross-beams without being in the way when the cars are required to be loaded with lumber and other material necessitating the use of the full length of the car. 4. The rack and pinion are well protected from dust or anything that might in any way impair the efficient working of the device; none of the working parts are exposed, and they are not, therefore, liable to get out of order.

Further information is obtainable from M. E. Bourne, Vancouver, B. C.

The Franklin Institute has awarded the Pantasote Leather Company, of New York, the Edward Longstreth Medal of Merit for the excellence of "pantasote" as a substitute for leather in many of its uses.

It is stated that the new gas engine, upon which experts in the employ of Mr. Westinghouse have been working, is now about perfected and its manufacture will be pushed by the Westinghouse Machine Company.

The Buffalo, Rochester & Pittsburg will erect at Du Bois, Pa., new car shops consisting of a mill building 60 by 200 feet; engine house, 60 by 125 feet; blacksmith and machine shop, 40 by 50 feet; storehouse, 48 by 80 feet, and paint shop, 24 by 96 feet.

The Pittsburgh Reduction Company, of Pittsburgh, Pa., recently rolled some aluminum plates 94 by 94 inches, for the United States government. One of the sheets after rolling was 150 by 100¼ inches, which is said to be the largest sheet of aluminum ever rolled.

The Stilwell-Bierce & Smith-Vaile Company, of Dayton, O., has closed a contract, amounting to nearly one half a million with a Montreal company for water wheels. It includes 34 wheels, and 21,000 horse power generated is to be conveyed electrically to Montreal.

An attempt is being made to reor anize the Rhode Island Locomotive Works, of Providence, R. I., which closed down last month for an indefinite period The concern has been for some time in the hands of a committee of the creditors. The contracts which the company had are completed and the committee ordered the shutdown.

The Carnegie Steel Company have placed with the Westinghouse Electric and Manufacturing Company an order for a complete electrical equipment for the Duquesne works. Power will be supplied for all light cranes, etc. There will be 16 large dynamos at the start and the installation will be so made as to permit of adding to it readily.

The Westinghouse Electric and Manufacturing Company has received a contract from the Baltimore, Cantonsville & Ellicott City Railway Company for 32 100-horse-power and 20 30-horse power electric motors for its new railway. The heavy motors will be used between Baltimore and Washington and the smaller ones for shorter runs.

The Brown Hoisting and Conveying Machine Company, of Cleveland. O., have received an order from Fried, Krupp, at Essen, Germany, for a complete hoisting and conveying plant for its blast furnace at Rheinhausen. This plant consists of three electrically operated Brown overhead bridge tramways, each machine having independent winding drums and motors. The company is to furnish all the working parts, including everything but the bridges proper, which will be built in Germany.

The Babcock & Wilcox Company write us as follows: "It having come to our notice that various parties are offering to build what purports to be Babcock & Wilcox boilers, we wish to notify all whom it may concern that no outside concern has been authorized to build our boilers. Without infringing a large number of patents owned by us no one can build other than a very antiquated form of Babcock & Wilcox boilers, and buyers are warned to be on their guard in dealing with anyone who offers them."

Mr. Quayle, Superintendent Motive Power of the C. & N. W. Railroad, expresses himself as being well pleased with the Salt Mountain asbestos as a lagging for his locomotive boilers. Having used it for a year with the best results as far as shown, he is now using it in its natural state for packing around cylinders and steam chests and in other places on his locomotives to prevent radiation of heat and condensation of steam. He is also making quite extensive use of it for stationary work.

Last month H. K. Porter & Company, of Pittsburgh, received orders for engines from foreign companies amounting to between $30,000 and $40,000. One of these engines is for a Russian railroad near St. Petersburg, where the engine is to compete with German engines. The engine will have a gage of but 29½ inches. A standard locomotive has also been ordered for San Salvador, Central America, and one is being built to haul asphalt at Trinidad, in the West Indies. A 30-gage engine is being built for a tramway at Port au Prince, Hayti, and two 40 ton locomotives are being constructed for use in the gold mines in South Africa, near Johannesburg. An experimental engine will also be built for use in Tiflis, in the Caucasus Mountains.

The electric locomotive exhibited by the General Electrical Company at the Chicago Exposition in 1893, which had a rated drawbar-pull of 7,000 pounds, has been purchased by the Manufacturers' Street Railway Company of New Haven, Conn. It is equipped with air-brakes and its total weight is 30 tons. It will be used to haul freight cars from the junction of the New York, New Haven & Hartford Railway at Cedar Hill, which is about one mile from the New Haven passenger depot, to the works of numerous manufacturing establishments located along the water front at some distance from the freight yards of the "Consolidated" road. The length of the line along which this locomtive will run is nearly two miles, the maximum grade being about 2¼ per cent.

Mr. Willis Shaw, 506 New York Life Building, Chicago, Ill., has just issued a catalogue of second-hand machinery of various kinds, which he has for sale and which are ready for prompt shipment. There are 20 pages in the catalogue and the machinery listed includes air compressors, air receivers, blowers, boilers, suspension cableways, contractors' dump cars, stone cars, channeling machines, hoists, derricks, ditching machines, drills, dredges, engines of various kinds, locomotives, ore crushers, pile drivers, cast-iron and steel pipe, contractors' plows, pumps and pulsometers, rails, road rollers and many others. All this machinery is stated to be in good condition and ready for service. Most of it is comparatively new and may be inspected in Chicago. Mr. Shaw is also ready to furnish new equipments. Copies of the list or catalogue will be sent on application.

The Monash-Younker Company, 203 South Canal Street, Chicago, Ill., has lately been incorporated for the manufacturing of steam and water specialties. The new company owns and controls all the specialties manufactured by the Van Auken Steam Specialty Company (mentioned several times in these columns), who will continue to manufacture their specialties, but those goods will be sold through the new concern, the Monash-Younker Company. This new company has also purchased the patent and plant of the Star Coupler Company, of St. Louis, and will manufacture Star lead pipe couplers and fittings for lead pipe plumbing without soldering or wiping a joint. Parties interested in high grade steam specialties or the new method of doing lead pipe plumbing without soldering or wiping joints should address The Monash-Younker Company for their catalogue and mention this journal.

Quite in contrast with the general dullness is the unusual activity displayed at the works of the Link Belt Machinery Company, Chicago, who have been operating their machine shop with two gangs of men both day and night during the past three months. The foundry is also being worked to its limit, one order for castings alone requiring 987,000 pounds of iron. A notable order is that for furnishing the Chicago Sugar Refinery with a complete equipment of machinery for handling coal from cars to iron bins located over 25 Babcock & Wilcox boilers in the power-house. From these bins, whose storage capacity is 650 tons, the coal is

spouted directly on to chain grates under the boilers. An order for the Huron Iron Company, Michigan, for two 8-foot, spirally grooved hoisting drums, together with a 11⅛-inch by 25-foot shaft, friction clutches, base plates, etc., and brake bands for running the drums independent of each other, both for hoisting and lowering, is nearing completion. The two friction clutches and brake bands are so arranged that they can be operated by one man without moving from one place to another, the operating mechanism being brought to the center of the frame.

The Westinghouse Electric and the Baldwin companies are to build a 75-ton electric locomotive for the Wheless system of electric roads. This system comprises an underground conductor, a series of buttons projecting slightly above the surface of the pavement between the tracks, and electro-magnetic switches to energize the buttons as the car passes over them. The electricity is taken from the buttons by long collecting bars suspended under the car. To start the car a current from a battery is sent through the collector bars and the buttons in contact with them. This current passes through a magnet in the switchbox under the buttons and raises an armature and brings into contact two sets of carbon discs. The current from the underground feeder wire now passes through the carbon contacts and thence through a coarse coil on the magnet, thereby assisting in holding the switch closed, and thence to the motors by means of the positive contact button and the corresponding collecting bar. From the motors the current passes to the rails or ground as usual. As the car advances the two collecting bars come into contact with the next group of buttons and the process is continually repeated. As the bars leave a set of contact buttons that particular circuit is open, the magnet armature falls by gravity, thus opening the switch and disconnecting the feeder from the positive button. Thus al the buttons are "dead" excepting those directly under the car. This is the system which the Westinghouse Company has adopted and on which so much practical experiment has been lavished.

The new large works of the Q & C Company, manufacturers of railway supplies and special machinery, which has recently been erected at Chicago Heights, a suburb of Chicago, is kept quite busy on orders for the well-known goods made by this company. They have recently secured orders for six large metal sawing machines, a number of which will carry saw blades 36 inches in diameter, and all but one of these machines are to be run by electric motors. The Bryant patent metal saw, as manufactured by this company, requires such a small amount of power to operate successfully that there is a growing demand for these machines equipped with motors, as the saving in actual cost for operation is considerable, at the same time giving equally efficient results. In addition to orders being received for their metal sewing machines, there is no lack of business in their railway equipment and tieplate departments. The output of the Servis tie plate alone this year will aggregate many millions.

The company is constantly receiving testimonials to the excellence of their sawing machines. One party says: "We now have in our works one No. 10 and one XX Bryant Sawing Machine. Our Superintendent is highly pleased with both. They do good work, they do a good deal of work, and do it very nicely, and do not require a skilled workman to operate them." Another says: "Have had one of your No. 10 Sawing Machines since April, 1892, and an XX Cold Saw for nearly two years. Both machines are in almost constant use and are giving us entire satisfaction." A third party says: "I have had it in use continually for nine months with the exception of intervals of a few days. I can cut a 70-pound steel rail in from 12 to 13 minutes, and have made cuts from ⅛ inch upward. I have had it in constant use for one and one-half days at a time before getting saw sharpened." Still another writes: "I secured this machine some two years ago and have not bought a set of crossings for renewals since. I usually make card template of the angular joint to be renewed and have it sawed and drilled at my supply yard or let foreman do it on the ground. I consider this saw the best money saving appliance I have on my division. The average time required to cut, say an angle of 45 degrees, is about 20 minutes."

New England Resorts via the Boston & Maine Railroad.

To travel is a pleasant and profitable diversion, and New England, with its widely varying interests, is a region through which one may tour indefinitely, and no matter which way you tour pleasing and interesting sights are always to be found.

The White Mountains of Northern New England are marvelously attractive, and the "Notch," the "Flume," the "Glen" or the Summit" are but a few of the many features of this wonderful region which you should visit. To one sojourning hereabouts many drives or walks over mountain and dale may be taken, reaping a harvest of pleasure unequaled in these parts; likewise the opportunities for enjoyment that are afforded at the beach resorts are manifold, ana the bathing, boating and fishing facilities attract many vacationists.

In no other region can you find so comfortable quarters as those of the hostelries of Northern New England, which are home-like and commodious. The cuisine is invariably of the best, and the service fully equal to that of the metropolitan hotels.

During the summer season the Boston & Maine Railroad sells round-trip tickets to all mountain, seashore and lake resorts of Northern New England and the Maritime Provinces, at reduced rates, and the excursion book which is issued by the General Passenger Department of the Boston & Maine, and which is sent free of expense to applicants, includes a complete hotel and boarding-house list, together with routes and rates to all principal points.

Our Directory

OF OFFICIAL CHANGES IN AUGUST.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Baltimore & Ohio.—D. C. Courtney is Division Master Mechanic at Grafton, W. Va., vice Mr. S. A. Souther.

Chicago, Kalamazoo & Saginaw.—Mr. Ed. Woodbury, of Kalamazoo, has been elected President.

Chicago, Hammond & Western.—General Manager J. P. Lyman has also been elected President.

Chicago Rock Island & Pacific.—A. L. Studer, Master Mechanic at Stuart, Ia, has been transferred to Trenton, Mo., on the Southwestern Division, and Mr. J. B. Kilpatrick, at Valley Junction, Iowa, has his jurisdiction extended over the West Iowa Division.

Columbus, Hocking Valley & Toledo.—N. Monsarrat has been elected Vice-President.

Columbus, Sandusky & Hocking.—W. E. Guerin is elected President and Charles Parrott Vice-President.

Denver, Lakewood & Golden.—Wm. W. Borst has been appointed receiver.

Duluth & North Dakota.—H. Fegraus, of Duluth, has been appointed Chief Engineer.

Galveston, Houston & Henderson.—Mr. F. P. Olcott has been elected President and Mr. J. H. Hill General Manager.

Galveston, Lea Porte & Houston.—S. R. Tuggle has been appointed Superintendent of Motive Power.

Great Northern.—General Manager Chas. Warren has retired. Mr. J. M. Barr, General Superintendent, has been assigned some of the duties heretofore performed by the Manager and the office will be abolished.

Green Bay & Western.—Mr. J. A. Jordan has been elected Vice-President.

Gulf, Colorado & Santa Fe.—Mr. L. J. Polk has been appointed Acting General Manager, vice Mr. B. F. Yoakum, resigned.

Kansas City, Fort Scott & Memphis.—Vice-President Ed. S. Washburn has been elected President of this road and also of the Kansas City, Memphis & Birmingham.

Kansas City, Fort Scott & Memphis.—Mr. D. W. McLean, Master Car Builder at Fort Scott, died last month.

Marietta & North Georgia.—Joseph McWilliams is General Manager, with office at Marietta, Ga.

Michigan Central.—Mr. S. B. Wight is Assistant Purchasing Agent with office at Detroit.

Oregon Central.—J. T. Walch has been appointed Master Mechanic and Master Car Builder.

Oregon Railway & Navigation Company.—Mr. Edwin McNeil has been elected President of the reorganized company.

Plant System.—Mr. Wm. Rutherford, Superintendent of Motive Power, has resigned.

Pittsburg, Chartiers & Youghiogheny.—J. M. Schoonmaker has been elected President, vice J. H. Reed, resigned.

Rio Grande & Eagle Pass.—Miss Mary Powers is Purchasing Agent with office at Laredo, Tex.

St. Louis, Chicago & St. Paul.—C. Millard has been appointed Chief Engineer with office at Springfield, Ill.

St. Louis Southwestern.—J. M. Scrogin is Master Mechanic at Tyler, Tex.; vice Mr. Thomas Irglis, deceased.

St. Louis & San Francisco.—Purchasing Agent E. T. Smith has resigned, and the office is abolished. General Manager Yoakum will purchase all supplies.

Sonora Railway, and New Mexico & Arizona.—E. P. Ripley has been elected President.

Southern.—W. A. Walden has been appointed Master Mechanic at Burlington, N. C., to succeed T. S. Inge, transferred to Columbia, S. C.

Texas, Sabine Valley & Northwestern.—R. B. Levy, Sr., has been appointed Receiver, vice L. H. Hart, resigned.

Texas Trunk.—Mr. William White, Superintendent, has been appointed Receiver to succeed Mr. G. T. Atkins, resigned. Office, Dallas, Tex.

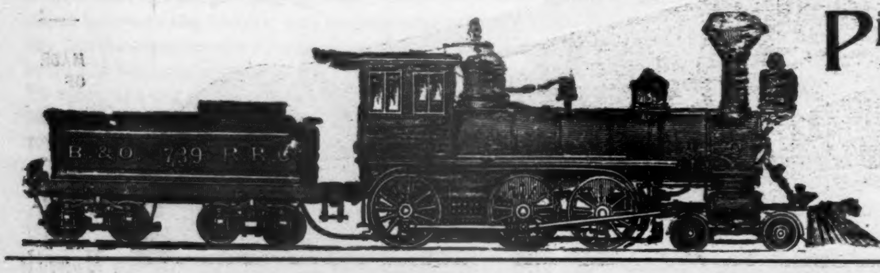
Washington & Columbia River.—J. Evans has been appointed Master Mechanic, vice Wm. Saxton, resigned.

THOMAS PROSSER & SON,
15 GOLD STREET,
NEW YORK.

KRUPP STEEL TIRES

On Locomotive Driving Wheels and on Steel-Tired Wheels

GIVE THE BEST RESULTS - - - FOR EVERY VARIETY OF SERVICE.



Pittsburgh Locomotive and Car Works,

PITTSBURGH, PA.
Manufacturers of LOCOMOTIVE ENGINES for Broad or Narrow Gauge Roads
From standard designs, or according to specifications, to suit purchasers.
Tanks, Locomotive or Stationary Boilers Furnished at Short Notice.
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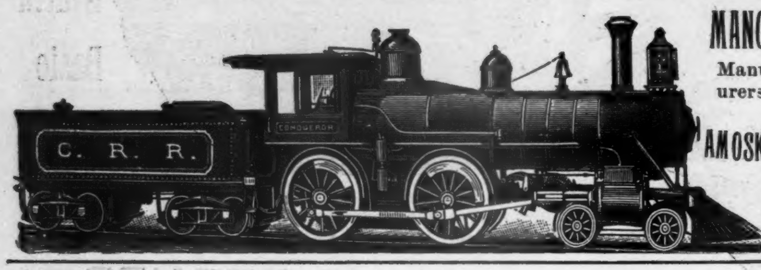

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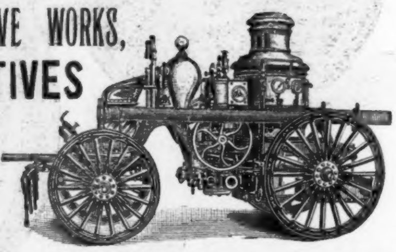

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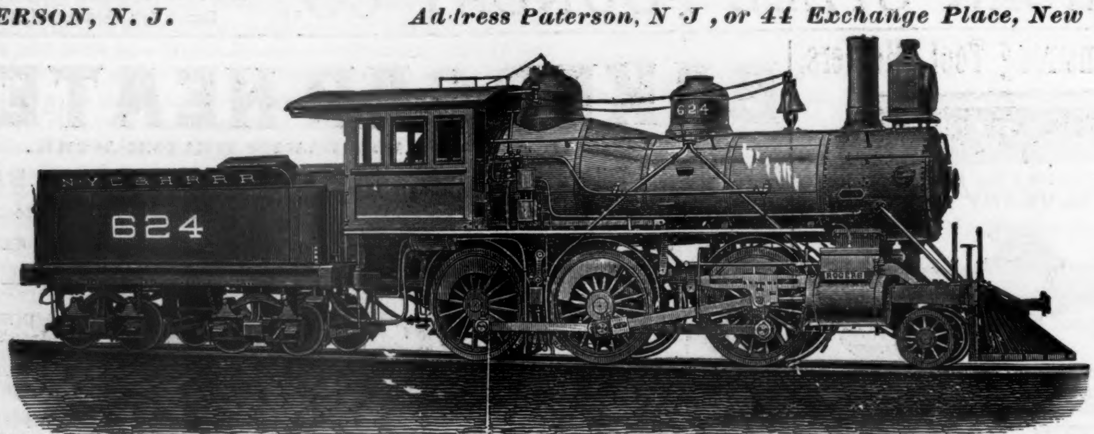

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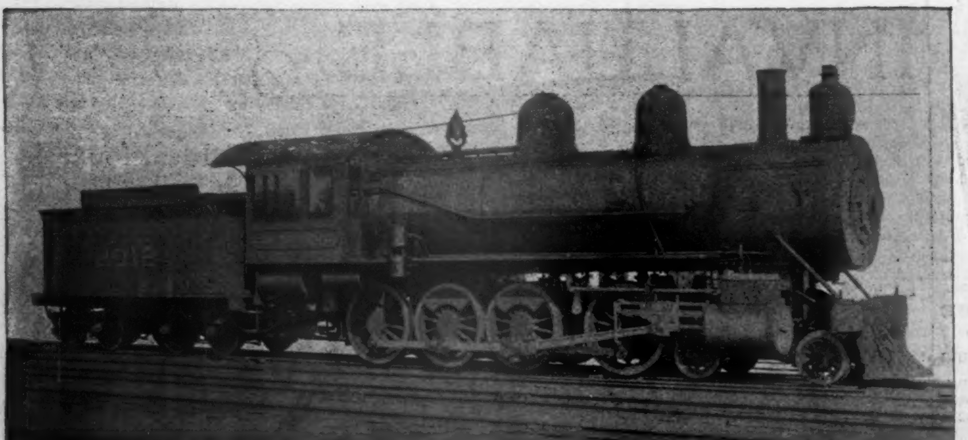

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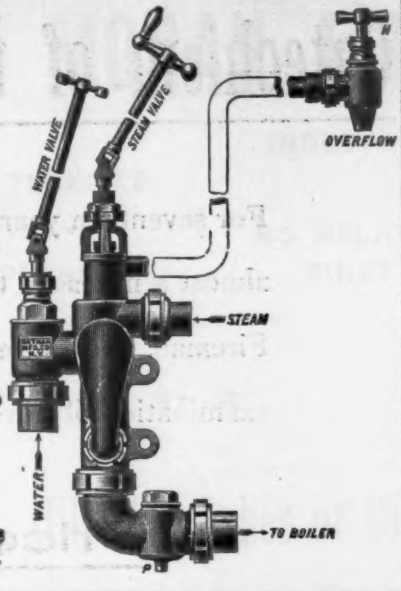

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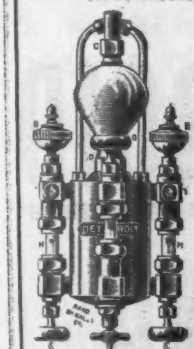

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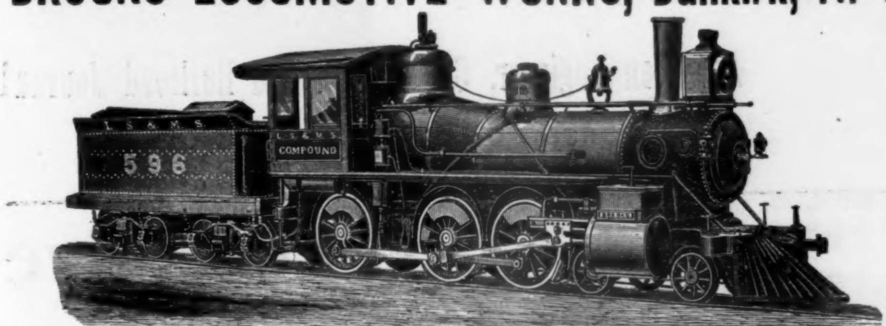

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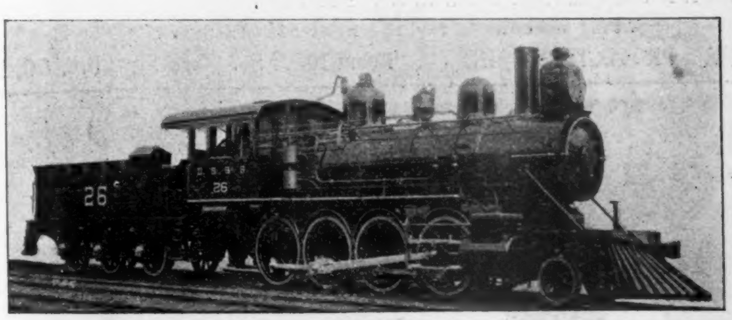

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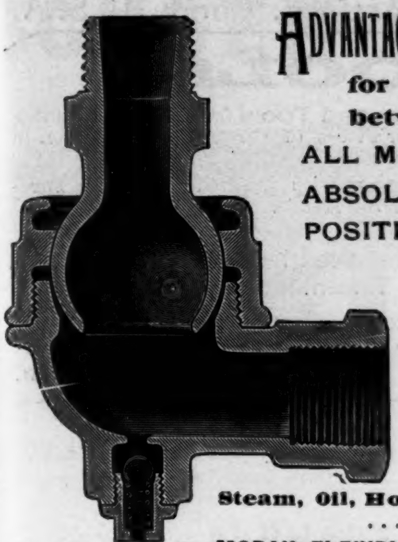

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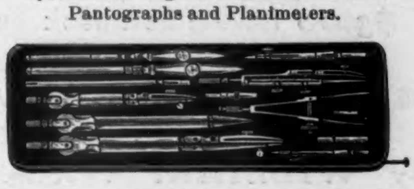

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